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COÖPERATIVE TRIAL PLANTING OF LOWLAND RICE IN CENTRAL AND NORTH CENTRAL LUZON

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FIVE PLATES

The Rosales Rice Experiment Station [1] located in Pangasinan and near Nueva Ecija, which are the two leading rice provinces of the Islands, used to be chiefly concerned in the production of rice. The station was engaged in testing promising varieties of rice and in propagating and distributing seeds. In 1923 when the coöperative trial planting system was established, it undertook preliminary field investigations on the existing rice varieties and began carrying on trials in different localities with rice varieties. At first its activities were limited to the Provinces of Pangasinan, Nueva Ecija and Tarlac, constituting the Fifth Investigational District of the old Bureau of Agriculture. Later on, the Sixth Investigational District comprising the Provinces of La Union, Ilocos Sur, Ilocos Norte, and Abra was placed under its supervision also. In these provinces are cultivated numerous varieties of rice. In Pangasinan alone there are about 120 varieties. It was found experimentally that only some 25 per cent of this number are good yielding, the rest having a low production. It is significant to note that Nueva Ecija Province not only has a much smaller number of rice varieties than Pangasinan, but the proportion of high yielding ones is larger.

[1] The Rosales Rice Experiment Station was closed in 1929.

PRODUCTION OF SEED PALAY

The rice seeds used for coöperative trial planting were produced in a series of variety tests conducted at the Alabang Rice Experiment Station, Alabang, Rizal. A brief description of the variety test is given by the senior writer in an article published in the Philippine Agricultural Review, Vol. XVIII, No. 1, 1925. From the results obtained the more productive varieties were found. The varieties exhibiting wide variation were submitted to pedigree selection in which a few selected plants of the same variety were grown in separate rows for three consecutive generations and the one or two making the best performance finally selected for propagation. The Apostol, Cruz, Macan, Mancasar, Khao Bai Sai, Sipot and others were produced in this way. The Macan Lamio, Inachupal, Azucena, Minalabon, Bulastog, Mambog, Contenido, and Cayading are merely selected varieties among hundreds tested at the Alabang and Rosales Experiment Stations. The Ramai was a pure line seed when received by the Bureau from Saigon in 1919.

SEED DISTRIBUTION

Selected seeds available for coöperative trial planting were usually advertised to the farmers by the Agricultural Extension Agents in their respective districts. Requests for the seed were made on B. A. Form No. 222 (Application for Coöperative Trial Planting), which the farmers filled out and sent to the Director of Agriculture, Manila. Requests were sometimes made through the Agricultural Extension Agents or the Station Superintendents of the Bureau. Most coöperators in Pangasinan secured their seeds while visiting the Rosales Rice Experiment Station at Rosales before the beginning of the planting season. Selected seeds distributed were accompanied by tags containing a brief description of the varieties. The amount of seed sent through the mail was considerable. One variety was sometimes sent in 2-ganta samples, but frequently two varieties were sent to one coöperator. The seed was furnished free on the condition that the coöperator would follow the instructions given him by the representative of the Bureau and submitted the necessary report at the end of the harvest. Government seeds were planted in plots, separate from the local variety, in size varying from 200 square meters to one hectare, with a general average of 1755 square meters. Otherwise the treatment was the same.

INSPECTION AND REPORTING SERVICE

The coöperators' plots were inspected by the personnel of the station and by the Agricultural Extension Agents in their respective districts, especially during the planting and harvesting season. Due to the great number of coöperative plots within the Fifth Investigational District and the limited personnel of the station, many of the plots had never been visited in previous years. The Agricultural Extension Agents had helped greatly in determining the area and crop yields from the plots. With a few exceptions the results of the trials were reported on B. A. Form No. 144 (Coöperator's Crop Record). In some cases it was necessary for the station's men to gather the information from the farmers while on special investigational trips.

PROGRESS REPORT OF RESULTS

PANGASINAN PROVINCE

1923—In Pangasinan the first coöperative plot was planted to Quinalibo II in the Hacienda Esperanza, Santa Maria, side by side with a local palay in 1923. Quinalibo II produced 70 cavans of palay per hectare while the local variety produced only 45 cavans. The Minalabon, planted in a plot at Rosales, produced 50 cavans per hectare as against 30 to 40 cavans of the common varieties. Sipot and Mangasa, the first dry-season crops ever planted at Umingan, produced 35 and 31 cavans respectively per hectare.

1924—Extensive work on the coöperative trial planting of lowland rice was undertaken in 1924 with 199 coöperators in 18 municipalities in Pangasinan. The coöperators submitted their reports as follows: 11 plots of Khao Bai Sai produced the average yield of 55.3 cavans per hectare; 5 Quinalibo II, 50.5 cavans; 7 Inachupal, 60.6 cavans; 6 Bulastog, 49 cavans; 3 Mambog, 57.7 cavans; 3 Cruz, 52 cavans; and 1 Ramai, 85.2 cavans. During the dry season 4 coöperators of Sipot obtained the average yield of 34 cavans and 6 coöperators of Mangasa 23 cavans.

1925—Eight plots of Khao Bai Sai produced an average of 62 cavans; 2 Inachupal, 68.1 cavans; 3 Quinalibo II, 50.5 cavans; 2 Cruz, 56 cavans; 1 Apostol, 71.4 cavans; and 1 Macan Piña, 76.1 cavans. Sipot produced an average of 45 cavans of palay in the irrigated farms of Tayug and Manaoag during the dry season that year.

1926—Seven plots of Ramai produced an average of 93.5 cavans; 3 Inachupal, 64.5 cavans; 2 Cruz, 61.5 cavans; and 2 Khao Bai Sai, 68.9 cavans. In the dry season Sipot produced the average of 41.5 cavans in 17 plots in Manaoag and 50.3 cavans in 7 plots in Tayug in 1926.

1927—In Rosales 7 plots of Ramai produced an average of 95.5 cavans; 3 Inachupal, 57.4 cavans, and 1 Apostol, 78 cavans. During the dry season 1 Sipot plot produced 56 cavans in Rosales; 4 plots, 40 cavans in Tayug; 2 plots, 35.5 cavans in Asingan; and 16 plots, 40 in Manaoag.

1928—In 1928 only Ramai and Apostol varieties were distributed for coöperative trial planting. Ramai produced an average of 112 cavans in 4 coöperative plots and Apostol, 78.2 cavans. In single plots in the Hacienda Porvenir, Tayug, Ramai gave 81 cavans, Azucena 70 and Khao Bai Sai 68. The local varieties Murmuray gave 63.6, Binituan 34, and Binalayang 59.2 cavans of palay per hectare.

1929—In the same plantation 68.4 cavans of Ramai were secured from one hectare, 80 cavans of Khao Bai Sai, 86.4 cavans of Elon-elon, as against 68 of Binacroy and 30.4 Binalayang. In Umingan 4 coöperators had an average of 92.5 cavans of Ramai; 8 coöperators, 75.6 cavans of Khao Bai Sai; in San Miguel, 23 cöperators had an average of 69.5 cavans of Ramai per hectare; in Asingan, 4 coöperators had 79.4 cavans of the same variety. In Rosales 5 coöperators produced Khao Bai Sai at 70 cavans per hectare; 2 Apostol at 84.3 cavans; and 1 Ramai, 87.3 cavans. In Mangatarem, 2 Ramai, 82.7 cavans; 1 Elon-elon, 88.3 cavans; and 2 Binacroy, 66.9 cavans. In Sual, 2 Ramai, 75.2 cavans; 2 Khao Bai Sai, 69.9 cavans. In Dasol, Ramai 95 cavans, Binacroy, 75.5; Elon-elon, 72.6; and Contenido, 60. In Balincaguing, Ramai produced 84.6 cavans; Elon-elon, 66.1 cavans, Binacroy 64.2; and Cayading, 57.6. In Bugallon, Ramai, 80 cavans; and Binacroy, 57 cavans; and in Aguilar, Ramai, 66; and Binacroy 58 cavans. During the dry season Sipot produced a naverage of 42.9 cavans in five coöperative plots.

NUEVA ECIJA PROVINCE

It was in 1923 that the Alabang Rice Experiment Station sent twelve selected lowland rice varieties for coöperative trial planting to the Central Luzon Agricultural School, Muñoz, Nueva Ecija. Of this lot Ramai and Binambang II yielded at the rate of over 200 cavans of palay in one hectare. In San Jose one coöperator produced 86 cavans from Ramai,: 83 cavans from

Bambang, 77 cavans from Inadhica, and 64.4 cavans from Macan Lamio on one hectare.

1924—The Central Luzon Agricultural School at Muñoz, cooperating with the Bureau of Agriculture reported that Ramai produced 111 cavass, Biñang 75 cavans, Mancasar 75 cavans, Macan Lamio 67.2 cavans, and Bambang 59.9 cavans on the average.

1925—In this year Ramai produced 122.9 cavans in Muñoz, Macan Lamio 90.7 cavans, Biñan 87.8 cavans, and Mancasar 86.3 cavans of palay. Other coöperators in Nueva Ecija reported the average production as follows: one plot of Ramai, 97 cavans; 3 plots of Khao Bai Sai, 75.6; 3 plots of Inachupal, 70.3; 2 plots of Macan Tago II, 77.5; and 3 plots of Cruz, 62 cavans per hectare.

1926—In Muñoz, again, Ramai produced 154 cavans, Mancasar 109 cavans, Macan Lamio 106.3 cavans and Biñan 102 cavans per hectare. It must be said that this exceedingly high rate of production was due to a number of factors, viz; a rich soil, good preparation of the soil, ample supply of irrigation water, besides the good seeds used.

1927—Ramai in 2 coöperative plots in Muñoz produced 101 cavans per hectare on the average; in 3 plots in Santo Domingo, 85 cavans; in 2 plots in Gapan, 63.3 cavans; in 2 plots in Cabanatuan, 92.2 cavans; and in 1 plot in San Jose, 93 cavans. Two plots each of Azucena, Apostol, and Khao Bai Sai averaged 72, 58, and 56 cavans per hectare respectively in Gapan. In Aliaga 4 plots of Inachupal gave 86.1 cavans on an average; in Cabanatuan 3 plots of Azucena produced 68 cavans; and in Guimba 3 plots of Apostol gave 50 cavans; and one plot of Minalabon, 64 cavans per hectare.

1928—In Aliaga 5 plots of Khao Bai Sai averaged 78.9 cavans; in Rizal one plot of Ramai gave 105 cavans; in Santo Domingo 2 plots of Ramai averaged 54.1 cavans and one plot of Elonelon produced 99 cavans; in Bongabon 2 plots of Ramai averaged 71.9 cavans; 2 plots of Khao Bai Sai, 66.6 cavans; 4 plots Apostol, 58.8 cavans; and 4 plots of Sipot, 58.3 cavans. In Cabiao 2 plots of Khao Bai Sai gave 62 cavans on average; in Talabera, one plot, 75 cavans; and in Zaragoza one plot 66.6 cavans.

TARLAC PROVINCE

In 1925 about 20 cavans of Khao Bai Sai, Inachupal, Minalabon and Calibo II were distributed to 28 coöperators in Tarlac, 7 coöperators in Moncada, 3 coöperators in Gerona and 2 co-

operators in Paniqui through the Agricultural Extension Agent of the province. It was reported that most of the coöperative plots were badly affected by drought that year. An investigation made by the personnel of the Rosales Rice Experiment Station in 1928 showed, however, that Khao Bai Sai (called locally "Kabasi" or "1236") had become a commercial rice variety.

LA UNION PROVINCE

The work on coöperative trial planting with rice in La Union Province began in 1927, when Sipot was introduced to the farms within the Amburayan River Irrigation System. Sipot produced 50 cavans per hectare in Bangar and 24 cavans in Balaoan with irrigation during the dry season.

1928—In Bangar Ramai in 4 coöperative plots gave 110.1 cavans on the average; 2 Apostol, 71.7 cavans; 2 Azucena 61.1 cavans in the rainy season; and 10 Sipot, 40.9 cavans during the dry season.

1929—Extension work on coöperative trial planting of rice was undertaken in La Union in 1929. The results were as follows: An average yield of 71.1 cavans of Ramai was obtained in Luna from 38 plots; 66.65 cavans of Ramai in Balaoan from 28 plots; 60.3 cavans of Khao Bai Sai from 16 plots and 50 cavans of Apostol from 2 plots. In Bauang with Ramai 70 cavans was obtained from 2 plots; and with Khao Bai Sai 57.9 cavans. In San Juan Ramai averaged 55 cavans in 2 plots and in one plot yielded 62.25 cavans. In Rosario 2 plots of Ramai yielded at an average of 52 cavans per hectare.

There were 72 coöperative plots of Sipot producing 40 to 61 cavans or an average of 51.4 cavans per hectare in the dry season planting in the Amburayan River Irrigation System in 1927. The farmers produced approximately 600 cavans of Sipot palay in Bangar and in Sudipen, during the dry season of 1927.

ILOCOS NORTE AND ILOCOS SUR

Different varieties of rice have been sent to Ilocos provinces for coöperative trial planting since 1925. The Ilocos farmers have become most interested in the success of the variety Sipot as a dry season crop within the Government irrigation system. The project engineer of the Laoag–Vintar Irrigation System produced in his coöperative trial plots at the rate of 64.3 cavans of Sipot per hectare by transplanting, 46.6 cavans by drilling, and 40.0 cavans by broadcasting in the dry season of 1926. In Tagudin Sipot also produced 45 cavans that season.

The following list gives the name of provinces and the number of new coöperators in the Fifth and Sixth Investigational Districts for the year 1929:

Province	Number of coöperators for dry season rice	Number of coöperators for regular season rice	Total number of coöperators
Pangasinan	16	123	139
Nueva Ecija	2	51	53
Tarlac	0	7	7
La Union	74	209	283
Ilocos Sur	0	17	17
Ilocos Norte	24	0	24
Abra	0	12	12
Nueva Vizcaya	0	10	10

SUMMARY

This paper contains a progress report of the coöperative trial planting of lowland rice in the North Central Luzon and in La Union and Ilocos provinces during 1923–1929, inclusive. The seeds used were selected varieties and included pure lines. They were distributed in response to requests to the Central Office either directly, or indirectly through the field men of the Bureau, individual coöperators being furnished with small quantities of at least two varieties. In the proper conduct of the experiments the men in charge of the rice experiment stations and the extension agents of the Bureau coöperated and in many instances helped the coöperating farmers locate the plots and plant the rice therein, as well as make reports on the results of the experiments.

The following table will show the number of coöperative plots planted to the principal varieties tested, the average yield obtained from each variety, and the extreme variations of the

Variety name	Total number of coöperators from 1923 to 1928, inclusive	Mean area of plots	Maximum yield per hectare	Minimum yield per hectare	Mean yield per hectare
RAINY SEASON		*Sq. m.*	*Cavans*	*Cavans*	*Cavans*
Ramai	43	3,043	164.0	60.0	100.0
Khao Bai Sai	27	2,091	117.0	40.0	59.7
Inachupal	22	2,154	108.0	51.5	71.5
Apostol	15	3,110	87.0	44.0	68.3
Cruz	13	1,436	72.6	42.0	57.4
Calibo II	9	932	74.3	22.9	54.5
Azucena	8	1,643	107.0	37.0	65.0
Bulastog Ortoc	7	1,302	65.4	36.1	50.1
Macan Lamio	6	535	106.3	31.1	72.4
Mancasar	4	661	109.0	75.0	88.6
Mambog	3	888	70.7	51.0	60.5
Macanining	3	2,813	80.0	53.5	61.5
DRY SEASON					
Sipot	76	4,118	68.0	12.0	41.8
Mangasa	6	3,695	35.9	12.3	22.9

yields. By far the highest average yield was that of Ramai, which amounted to 100 cavans per hectare from 43 coöperators in the Provinces of Pangasinan, Nueva Ecija, and La Union. This variety and the Inachupal, Macan Lamio and Mambog were found adapted to irrigated lands. The Khao Bai Sai, Apostol, Cruz, Minalabon, and Calibo II, on the other hand, were found to be adapted to the semi-irrigated regions in Nueva Ecija and Tarlac. Sipot has become established a dry season crop within the irrigation systems in La Union, Ilocos Norte, and Ilocos Sur, and the areas planted to it have been increasing yearly.

An investigation conducted by the personnel of the Rosales Rice Experiment Station, in 1929, showed that there were at least 61 rice plantations ranging in area from 10 to 150 hectares that were planted to the varieties of rice selected by the Bureau in the Province of Nueva Ecija; 43 farms in Pangasinan planting 10 to 200 hectares each and 27 farms in Tarlac planting 10 to 120 hectares each.

It is estimated that in the three provinces mentioned there were at least 50,000 hectares planted to selected rice seeds with a total production of 320,000 cavans, valued at ₱1,000,000.

ILLUSTRATIONS

PLATE I. (*a*) Preparing seeds of selected varieties for distribution, Rosales Rice Experiment Station, Rosales, Pangasinan.

(*b*) Rice seeds in 2-liter and 6-liter lots delivered for mailing at Rosales, Pangasinan, Post Office.

II. (*a*) Ramai rice grown on a field scale in Tayug, Pangasinan, 1928.

(*b*) Plot yields were measured after harvest and put in sacks.

III. (*a*) Heavy crop of Ramai in irrigated field in San Nicolas, Pangasinan. Regular season of 1928.

(*b*) Harvest of coöperative plots in Hacienda Esperanza, Rosales, Pangasinan. Ramai rice in "mandalas" on the left; Inachupal rice on the right.

IV. (*a*) Solid fields of Sipot rice grown within the Amburayan River Irrigation System, Sudipen, La Union, during the dry season of 1929. Second crop possible after the first rainy season crop.

(*b*) A main canal of the Amburayan River Irrigation System. All along the water course were patches of dry season rice of the Sipot variety like the one on the off side of the canal.

V. Governor De Guzman (x) of La Union Province presiding over a convention of farmers interested in growing second rice crops. The scene shows land under the Amburayan River Irrigation System where an excellent crop of Sipot had just been harvested May 18, 1929.

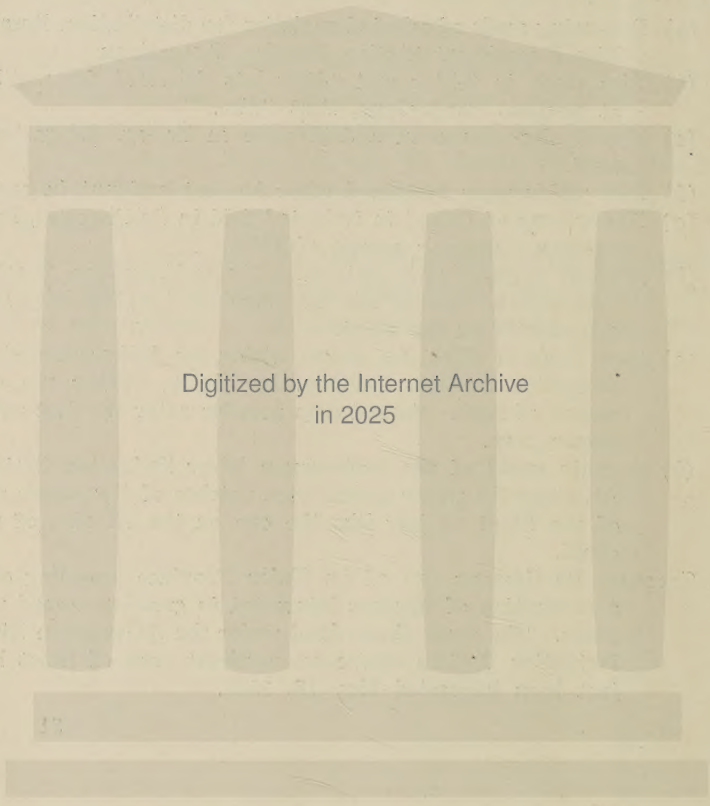

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PLATE I

(*a*) Ramai rice on a field scale in Tayug, Pangasinan, 1928

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PLATE II

(*a*) Heavy crop of Ramai in irrigated field in San Nicolas, Pangasinan. Regular season of 1928

(*b*) Harvest of coöperative plots in Hacienda Esperanza, Rosales, Pangasinan. Ramai rice in "mandalas" on the left; Inachupal rice on the right

PLATE III

(*a*) Solid fields of Sipot rice grown within the Amburayan River Irrigation System, Sudipen, La Union, during the dry season of 1929. Second crop possible after the first rainy season crop.

(*b*) A main canal of the Amburayan River Irrigation System. All along the water course were patches of dry season rice of the Sipot variety like the one on the off side of the canal.

PLATE IV

PLATE V. Governor De Guzman (x) of La Union Province presiding over a convention of farmers interested in growing second rice crops. The scene shows land under the Amburayan River Irrigation System where an excellent crop of Sipot had just been harvested May 18, 1929

NOTES ON A VENOMOUS SPIDER IN THE PHILIPPINES [a]

(*Latrodectes sp.*—near *hasselti* Thorell)

By F. Q. Otanes
Acting Chief of Plant Sanitation Division of the Bureau of Plant Industry

TWO PLATES

Late in July, 1931, Mr. Remigio Abello, a planter of Isabela, Occidental Negros, sent specimens in alcohol to the Bureau of Animal Industry of a species of spider (locally known there as *banayaw*) which he reported to be poisonous, saying that two of his cattle on his stock farm on the mountains near Isabela, had died as a result of bites by this pest. He was quite positive that bites by members of the species were the cause of the deaths of his cattle. The specimens sent by Mr. Abello to the Bureau of Animal Industry were referred by that Bureau to the Bureau of Plant Industry. Some of these were sent to Dr. H. E. Ewing, of the United States National Museum, for identification, with the remark that the spiders appeared to be related to, or belonged to, the same genus as the "black widow" or "hour-glass" or "shoe button" spider (*Latrodectes mactans* Fabr.) in California and the Southern States and other countries, which is known to be highly venomous, with cases of fatal bites by them recorded. In a letter, dated December 17, 1931, Doctor Ewing verified our generic identification of the spiders sent him, saying:

> They belong to the genus *Latrodectes* and are very very near the species *hasselti* Thorell. However, they are not this latter species which occurs in India. Doubtless this species is poisonous to a certain degree.

According to Herms, all spiders secrete venom by means of which they kill their prey. This is stored in a pair of glands located in the anterior portion of the cephalothorax.

Herms also says:

> While spider venom is very destructive to the life of insects upon which spiders prey, there is little evidence (with certain exceptions) to indicate that this venom is injurious to man. Most of our so-called spider bites

[a] Read before the First Philippine Science Convention, March 16, 1932.

are traceable to other sources, particularly cone-noses (Reduviidae). Comstock (1912) has given much attention to this matter and has come to the conclusion that there are no spiders that need be feared in the northern part of the United States at least and in the South there is only one dangerous genus, *Latrodectes.*

THE GENUS LATRODECTES

Perhaps the most notorious member of the genus is *Latrodectes mactans,* as already referred to. This occurs not only in the United States, but also in the Hawaiian Islands, West Indies, Madagascar, New Zealand, Algeria, and Peru. It is known simply as "the black spider," and descriptively as "hourglass" spider, from the hour-glass red mark on the lower surface of the abdomen; or "shoe button" spider from its resemblance to black shoe button; or the "black widow" from its habit, as a writer (Larsen, 1928), expresses it, "of devouring the male as soon as the latter has served his purpose as an impregnator—and as *Latrodectes mactans* because scientists believe learning should be basic—and hard!" It is said that the Indians of Southern California used emulsions of the spider for poisoning their arrows.

It is well to cite here some records of *Latrodectes mactans* bites on human beings. To quote Herms again:

> An account of a fatal case in North Carolina is given by Packard and Howard, viz.: an employee (farm laborer engaged in haling wood) of Mr. John M. Dick is reported to have been bitten by a black spider with a red spot on it at about 8.30 o'clock a. m., dying of the effects about fourteen hours later, i. e., between 10 and 11 p. m. The victim is said to have felt something crawling on his neck, and as he brushed it off it bit him very severely, causing very great pain. The cause was described as being a black spider with red spots. An examination of the neck revealed ten little white pimples, all of which could be covered with a one-dollar silver coin; no puncture was seen. There was no swelling, but the neck, left breast and arm were so hard that no impression could be made with the thumb. The man complained of pain running through his entire body. It should be noted that the man was perfectly healthy. By 1 o'clock the pain had settled in his bowels and shortly thereafter he was attacked with spasms. About 4 o'clock spasms recurred and the patient lapsed into unconsciousness and remained so until death.

Out of 150 persons sent to hospitals in the United States as a result of bites by *Latrodectes mactans,* ten died, according to Larsen.

Other species of the genus *Latrodectes* which are likewise poisonous are also recorded from certain other countries. Among these are *L. malmigniatus* of Southern Europe and *L.*

hasselti of New Zealand, Australia, and East Indies. As Doctor Ewing says, *L. hasselti* also occurs in India.

Our local poisonous spiders (the mature females) from Isabela, Occidental Negros, are about one centimeter long when full grown, black, with two prominent bright red spots, one on the dorsal and another on the ventral surface of the abdomen, the dorsal mark being larger. The ventral mark is shield-like or crown-like in outline, while the dorsal is elongated. In this respect it differs from *Latrodectes mactans* which, according to description, has a red spot only on the nether or ventral surface of the abdomen. The males are considerably smaller, slender, and noticeably lighter in color. The spots are only slightly reddish. The distal portion of each maxillary palpus, as in the case of certain other spiders, is greatly enlarged into a somewhat complicated knob-like process, which can not be easily described. Each is provided with an appendage coiled after the manner of a watch spring.

In compliance with a request, Mr. C. T. Buligan, assistant agronomist of the Bureau of Plant Industry, who is assigned to Occidental Negros, sent to the Central Office of the Bureau of Plant Industry a few live specimens for experimental purposes in carefully covered bottles inside a strong box.

At about 11.30 a. m. on December 5, 1931, I had a male white rat from Singalong bitten by some of the spiders received from Mr. Buligan. About half an hour later, the rat showed distinct signs of spasms or convulsions. At about 3 o'clock that day the rat was apparently weak and on Monday morning, December 7, 1931, the animal was found dead. It apparently died Saturday night (December 5).

On the same day, December 7, 1931, I had three birds locally known as "mayang costa" (*Munia oryzivora* L.) bought. I had two of these bitten on the fleshy portion of underside of the wings and kept the third one as a check. The spiders were held by the legs with a pair of forceps. Their mouths were then held in contact with the birds' parts as indicated and the spiders were found to bite the birds readily. About 20 minutes later the birds bitten began to show signs of inactivity. They closed their eyes and opened their beaks very often, revealing difficulty in respiration. At about five o'clock one of the birds died and the other also died the following morning.

These tests, few and simple though they may be, leave no doubt that our local *Latrodectes* are venomous, and that the al-

legation of Mr. Abello that his cattle died of venom of the spider in question was not at all impossible. Information had it that the spiders were rather abundant under stones and other objects in the corral and other places on Mr. Abello's stock farm at Isabela, due in part to the abundance of flies. The cattle that died might have been bitten in several places. It was also possible that the animals concerned died from other causes—snake bites for instance. But it may be stated, however, in this connection that this is not the first report of spiders being suspected of having caused the death of stock as a result of their bites. Way back in 1927, an American, Mr. Maage, submitted in person one female specimen of the same spider to the then Bureau of Agriculture, with the report that it was poisonous to stock in Buayan, Cotabato. In view of the fact that no suitable living specimens could be got, no test was then made.

This local venomous spider certainly warrants further study in order that people, especially where the spiders are abundant, can be properly warned as to the danger from those creatures not only to their stock but more especially to themselves. If it is venomous to stock, as alleged, and to other animals, as our tests indicate, there is hardly any doubt that it is also venomous to man. Trials on stock and other animals, such as monkeys with an attempt to study the nature of the poison and to find out effective antitoxin or sera and other remedies would certainly be valuable. It is especially important for children who often are very fond of playing with spiders to recognize this particular spider and to realize the danger from handling it. Some of us who are fond of outings, out of curiosity, may pick up a spider and the new friendship may end disastrously. The public has already been warned by the Director of Plant Industry about the venomous character of this spider (see Manila *Tribune,* December 9, and *Philippines Herald,* December 14, 1931).

Data should be gathered too as regards the distribution of this spider in the Philippines and the conditions under which they are abundant, so that people can be warned accordingly and steps taken to at least reduce their numbers to minimize danger from them. Not only from the two places aforementioned has the spider been collected. The writer has seen specimens in alcohol from Tayabas. It seems that the species is found in many parts of the Islands, although it does not seem to be so common in the immediate neighborhood of populated areas.

The life cycle of the species, judging from records in Manila, lasts about four months. It is probably shorter in the field—in nature.

SUGGESTIONS AS TO REMEDIES FOR THE BITES OF, AND AS TO THE CONTROL OF, THE SPIDER

The following suggestions in regard to the treatment of bites on human beings by *Latrodectes mactans* given by Doctor Herms may be helpful in the treatment of local cases:

> The successful treatment of *Latrodectes* bites for a number of reported cases has been a local application of supersaturated aqueous solution of permanganate of potash every two hours. Escomel advises also, internally, a teaspoonful of a solution of permanganate (1 to 4,000) every three hours with a milk diet. Escomel also recommends this treatment for the bite of *Gliptocranium gasteracenthoides* Nicolet the "pruning spider" of Peru which he considers even more dangerous than *Latrodectes.*
>
> Kellogg reports that Sachs succeeded in producing a highly effective antitoxic serum by treatment of the blood of guinea pigs with arachnolysin; 0.0025 cubic centimeters of this antitoxin serum is sufficient to protect 0.05 cubic centimeters of rabbit blood from an otherwise hemolyzing dose of arachnolysin.

Larsen also gives the following:

> The most unique therapeutic measure reported by Bogen is the use of blood from a patient who had recovered. Twenty-five cubic centimeters of this blood were injected intraveneously into a patient soon after he had been bitten. The result was marked improvement within a much shorter time than could otherwise be expected.

The following suggestions are hereby made for controlling the spider:

1. Parts of pastures where the spiders are found abundant may be burned over during the dry season in order to kill the spiders and their young. Corrals should be kept free of stones, pieces of wood and other rubbish where the spiders may hide.
2. The adult spiders may be killed by simply striking them with brooms or with sticks since it is not probably difficult to see them on the grass or other plants where they make their webs.
3. Spraying with a strong enough concentration of kerosene or other oil emulsions of ordinary soap solution may also be done to kill the spiders.
4. The egg sacs, which are white and globular, and can be easily seen, should also be collected and destroyed.

5. A study of the natural enemies of the spider should be made with a view to encouraging their multiplication.

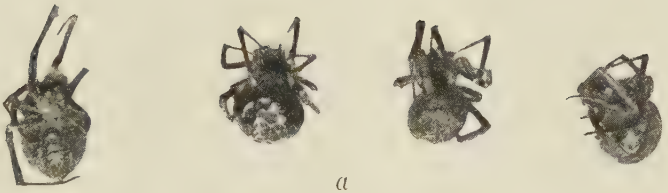
LITERATURE CITED

1. Herms, W. B. 1923. Medical and Veterinary Entomology (Second Edition).
2. Larsen, N. P. 1928. The Black Spider. The Mid-Pacific Magazine, Vol. 36, No. 1, pp. 13–14.

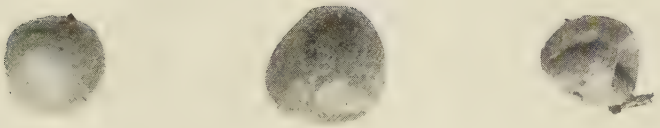
ILLUSTRATIONS

PLATE I. Adult female spiders (*a*) and egg sacs (*b*), about the natural size (*Latrodectes* sp.).

II. Dorsal (*a*) and ventral (*b*) views of the spider (*Latrodectes* sp.)—(2 x). Lateral view (*c*) of the female (2 x) and dorsal view (*d*) of a young male (2 x).



a



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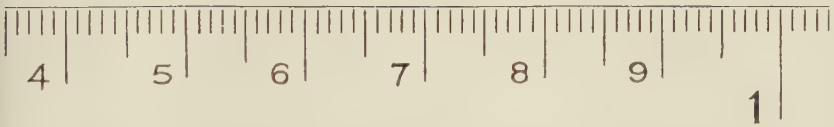
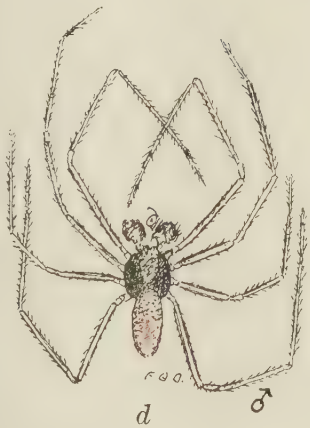


PLATE I. Adult female spiders (*a*) and egg sacs (*b*), about natural size (*Latrodectes* sp.)

a

b



d

c

PLATE II. Dorsal (*a*) and ventral (*b*) views of the spider (*Latrodectes* sp.)—(2 x). Lateral view (*c*) of the female (2 x) and dorsal view (*d*) of a young male (2 x).

SWEET POTATO EXPERIMENTS AT THE LAMAO EXPERIMENT STATION, LAMAO, BATAAN

By F. G. Galang

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Of the root crops under cultivation in the Philippines, the sweet potato, which is commonly called "camote," *Ipomoea batatas* L., is the most widely cultivated. In 1930 alone there were 83,463 hectares of land planted to camotes and with a total production of 177,657,600 kilograms of tubers valued at ₱3,455,570 against 40,194 hectares planted to cassava, gabe, Irish potatoes, tugui, and ubi during the same year and with a total production of 69,871,300 kilograms of tubers worth ₱2,309,030. During the same year there was an importation of 82,873 kilograms of camote tubers valued at ₱4,781 from China, the United States, and Japan, which importation was practically consumed in Manila.

Camotes are planted both as a field crop and as a garden vegetable, and the tuber is the main food for the mountain people as is rice for the lowlanders. The camote when eaten is reported to give the most heat and energy; while Irish potatoes give the most tissue building material. Not only are the camote tubers used for food but also the young leaves or tops. Camote leaves are reported to contain 10.25 per cent carbohydrate, 1.15 per cent protein, 0.42 per cent fat, 1.98 per cent ash, 1.90 per cent crude fiber and 84.20 per cent water; and found positive for vitamin B and C. Tuber samples of fourteen varieties or strains cultivated by the Bureau of Plant Industry sent to the Bureau of Science for analysis gave the following results:

Table I.—*Analysis of sweet potatoes*

Variety name	Moisture	Ash	Protein	Fat	Crude fiber	Carbohydrate
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Unnamed variety-R. E. G. Y.	50.254	1.476	1.455	0.536	0.938	36.341
Guinobatan No. 1	63.906	1.358	1.545	0.432	0.950	31.809
Pattoke	71.106	1.098	1.044	0.588	1.340	25.824
Samar Big Yellow	59.040	1.300	2.180	0.329	0.894	36.194
S. B. Y. No. 98	71.946	1.284	0.699	0.488	0.860	24.723
Linoco	62.020	0.948	1.008	0.546	0.908	34.570
Toguicao	61.420	1.104	0.883	0.508	0.976	35.109
Momungan	64.178	1.184	1.310	0.570	0.774	31.984
Tato No. 1	68.400	1.064	1.023	0.366	0.970	28.177
Tato No. 2	55.508	0.816	1.300	0.522	0.916	40.938
Tarlac No. 2	65.232	1.328	1.613	0.340	0.904	30.583
Blo. No. 38	57.760	0.840	1.205	0.508	0.850	38.837
Sealey	68.652	1.112	0.853	0.430	0.752	28.201
Unnamed variety	51.384	1.126	1.580	0.318	1.158	44.434
Average	62.772	1.146	1.264	0.467	0.942	33.409

The investigational work under review consists of the following:

(1) Variety test,
(2) Comparative test of planting base, middle and apical cuttings,
(3) Distance of planting,
(4) Ridge *versus* Furrow Planting, and
(5) Storage experiment.

VARIETY TEST

The multiplication of the camote varieties or strains to supply the needed planting materials for the various experiments on this crop at the Lamao Experiment Station, Lamao, Bataan, started as early as 1920 with some of the varieties or strains of camote but a regular variety test commenced in 1922 only.

The yearly average productions per hectare in the Philippines from 1922 to 1930 were 2.515, 2.345, 2.3, 2.304, 2.309, 2.308, 2.151, 2.121, and 2.128 tons of tubers, respectively. At the Porto Rico Agricultural Experiment Station(1) a yield of more than 36 tons of tubers per hectare was obtained from the Key West and Madeira varieties of sweet potatoes in 1924. These two varieties gave the highest yields among the 40 varieties tested in that station. In the British Virgin Islands(2) sweet potatoes yielded at the rate of from 0.82 ton per hectare for Black Vine to 8.246 tons for Spooner. At the St. Kitts-Nevis Experiment Station of the Imperial Department of Agriculture, West Indies(3) the three highest yielding varieties per hectare were Brass Cannon—17.781 tons, Playwell—17.09 tons, and Caroline Lee—16.678 tons. At the Pennsylvania Agricultural Experiment Station, U. S.,(4) the Southern Queen gave a yield of 24.262 tons to the hectare. Merino(5) reported a yield ranging from 1.655 to 24.164 tons of tubers to the hectare. And of the 29 varieties or strains tested the Samar Big Yellow, the Ucab, the Iningcanto, and the Montevideo were the best yielding varieties with their corresponding yields of 24.164, 23.126, 23.000, and 16.783 tons of tubers to the hectare, respectively. Muñoz(6) reported a yield ranging from 0.866 to 23.953 tons of tubers per hectare; and of the 20 varieties or strains of camote planted the four highest yielding varities with their corresponding yields of tubers per hectare were Bacoboco Red—23.953 tons, Caniang—15.642 tons, Iningcanto—15.528 tons, and Maragadan—12.756 tons. Table II gives the average yields of tubers in tons per hectare of the variety test of sweet potatoes conducted at the Lamao Experiment Station, Lamao, Bataan, from 1922 to 1930.

TABLE II.—*Variety test of sweet potatoes*

Variety	Number of trials	Average yield in tons per hectare
American White	3	10.205
American Large White	6	7.193
Blo. No. 38	3	4.835
Bacongan	3	7.141
Camarinay	6	7.786
Canegro	4	11.140
Corodicod	1	1.412
Guinobatan White No. 1	3	8.907
Guinobatan No. 2	5	7.598
Georgia Yellow Yam	6	4.053
Hawaii No. 1	7	7.676
Jersey	6	4.336
Jersey Red	4	7.328
Jersey Yellow	1	4.515
Kinalamias	5	8.812
Lapugao	5	3.084
Laoc	1	10.857
Los Baños No. 1	3	7.739
Los Baños No. 2	5	6.087
Los Baños No. 3	3	9.919
Linoco	8	4.437
Longan	4	2.277
Mintal	5	12.899
Momungan	4	16.649
Pattoke	6	6.086
Processana	3	1.865
Pitay	4	4.609
Shanghay	4	1.306
Samar Big Yellow	8	6.644
Sealey	8	5.561
Samar Big Yellow No. 98	2	6.920
Tarlac No. 1	6	4.040
Tarlac No. 2	5	6.731
Tarlac No. 3	4	6.335
Tarlac No. 4	3	9.902
Tarlac No. 5	3	6.268
Tato No. 1	6	9.854
Tato No. 2	2	8.961
Toguicao	5	3.368
Tabao	4	5.320
Ubi	2	2.136
Unnamed variety	5	4.572
Total	181	277.363
Average	4.3	6.604

From the 1922 planting, consisting of 37 varieties or strains, only 11 finally succeeded. Poor yields were obtained because of the poor soil of the land, which was the only land available at the time of planting. Planting was done on October 3, 1922, replicated twice in a plot of 10 by 5 meters or 50 square meters for each at an average distance of 1 by 0.75 meter apart both in furrows and ridges. The crops were harvested in May and June, 1923; and the following varieties came out the best yielders: Guinobatan No. 2, 11.740 tons of tubers to the hectare; Guinobatan No. 1, 9.483 tons; and Tarlar No. 2, 8.678 tons. The yields of the other varieties ranged from 1.201 to 6.734 tons per hectare.

Of the 37 varieties or strains of camote planted in May and June, 1923, replicated three times in a 144 square meters plot

for each replication, both furrows and ridges 1 by 0.60 meter apart, and harvested in January and February, 1924; the four highest yielding varieties in the order of their importance were the American White yielding 7.453 tons of tubers per hectare, Canegro—6.787 tons, Tarlac No. 3—6.657 tons, and Tarlac No. 5—6.387 tons. Other varieties yielded from 1.156 to 5.907 tons to the hectare.

In 1924 poor yields were obtained from the 36 varieties or strains of camote on account of the poor land and early planting. Planting was done in three replicated plots on April 1, 1924, which resulted only in the vegetative growth of the camote vines instead of tubers. However, the varieties Canegro, Samar Big Yellow, American Large White, and Jersey gave the best yields in the order of their enumeration. These varieties yielded 17.681, 8.147, 7.841, and 7.238 tons of tubers per hectare, respectively. The other varieties yielded only from 0.318 to 6.387 tons of tubers to the hectare. Each variety occupied a plot of 120 square meters, and was planted 1 by 0.60 meter apart. Harvesting was done in December, 1924.

The harvest from the 1925 culture was so far the best, but due to the invasion of the sweet potato weevil, *Cylas formicarius,* most of the tubers became useless for human consumption. Of the 30 varieties or strains planted in the replicated plots, the five best yielding varieties in the order of their enumeration were Momungan, giving 30.665 tons of tubers per hectare; Tato No. 1, 22.775 tons; Mintal, 20.765 tons; Tarlac No. 4, 20.264 tons; and Los Baños No. 3, 20.176 tons. The other varieties yielded from 1.358 to 18.69 tons to the hectare. Planting was done July 23–24, 1925, at a distance of 0.75 by 0.5 meter apart, and the crops were harvested January 6–11, 1926. Each variety or plot occupied an area of 72 square meters. The results showed that July is the best month for planting camotes under Lamao soil and climatic conditions.

The 1926 culture, consisting of 29 varieties or strains of camote planted September 16–17, 1926, at a distance of 0.75 by 0.5 meter apart, replicated three times in a 90 square meter plot, which was harvested in February, 1927, showed that Mintal, American Large White, Tato No. 1, Tabao, and Pitay were the five best yielders in the order of their enumeration. The computed yields of tubers per hectare were Mintal, 18.194 tons; American Large White, 12.840; Tato No. 1, 12.418; Tabao, 12.149; and Pitay, 10.937. The other varieties yielded only from 2.039 to 9.501 tons of tubers per hectare.

From the 24 varieties or strains planted September 10–14, 1927, replicated three times in a 60-square-meter plot at a distance of 0.75 by 0.5 meter apart in ridges, and harvested January 23–24, 1928, the five highest yielding varieties per hectare were Tato No. 1, 18.700 tons of tubers; Mintal, 18.35 tons; Momungan, 16.188 tons; Camarinay, 15.171 tons; and Kinalamias, 14.352 tons. The other varieties gave only from 1.412 to 12.175 tons to the hectare.

Of the 22 varieties or strains planted in a 105-square-meter individual plot at a distance of 1 by 0.6 meter apart in August, 1928, in three replications, and harvested January 22, 1929; the five best yielders per hectare in tubers were Hawaii No. 1, 11.815 tons; Momungan, 11.274 tons; Laoc, 10.857 tons; Guinobatan No. 2, 10.25 tons; and Sealey, 10.115 tons. The other varieties yielded only from 0.109 to 9.780 tons of tubers to the hectare.

There were only 13 varieties or strains of camotes tested in 1929. Planting was done September 17–20, 1929, and harvesting in March, 1930. Each variety occupied a single plot of 174 square meters. Very poor yields were obtained from this culture, and the highest yielding varieties gave only 3.271 tons of tubers to the hectare for the Hawaii No. 1 and 3.071 for the Jersey, and the rest from 0.975 to 2.979 tons a hectare.

In the eight years variety test of camotes as given in Table II; the Momungan, Canegro, Mintal, and American White outyielded the other varieties included in the test of this crop, and each gave a yield of over ten tons of tubers to the hectare. The Laoc variety of camote gave a yield of over ten tons of tubers to the hectare from a single test. There was a general average of 6.604 tons of tubers per hectare in this variety test, which was over the Philippine yearly average productions from 1922 to 1930.

A COMPARATIVE TEST OF PLANTING BASE, MIDDLE AND APICAL CUTTINGS

In the Philippines farmers plant camote cuttings irrespective of the kind or portion of the vine in spite of the fact that one of the factors which determines the yield of any given crop is the proper selection of the planting materials of that particular crop. This is also true for the camote. It was, therefore, the object of this experiment to find out which section of the camote vine gives the best yield. For the purpose of this experiment the whole vine was apportioned into three different parts, and these designated as the base, middle and apical cuttings. The

base cutting represents a one-foot cutting obtained from the base of the vine, and the apical cutting a foot from the growing point or tip of the vine toward the base or central portion, while the middle cutting represents that portion between the base and the apical cuttings. Cuttings procured from each of these portions were cultured in separate plots side by side with the other two to determine their respective yields. To check the yearly results during the six years duration of the experiment several varieties or strains of camote were tried. As for instance in 1923, the Jersey Red, Georgia Yellow Yam, Guinobatan No. 1, and Chinese camotes were planted. In 1925 to 1928, the Samar Big Yellow, the Mintal, and the Sealey varieties were cultured exclusive for this test, while in 1929, Tato No. 1, Hawaii, Tarlac No. 1, Sealey, Kinalamias, Longan, Pitay, Lapugao, Processana, Jersey, Camarinay, and Unnamed variety were experimented with using the Georgia Yellow Yam as check. The results of these tests in tons of tubers to the hectare are tabulated below:

TABLE III.—*Comparative yield of base, middle and apical cuttings of sweet potatoes*

Variety	Base cuttings		Middle cuttings		Apical cuttings	
	Yield	Number of trial	Yield	Number of trial	Yield	Number of trial
	Kilos		*Kilos*		*Kilos*	
Camarinay	2.043	1	4.688	1	5.961	1
Chinese	6.916	1	36.333	1	17.333	1
Georgia Yellow Yam	2.750	1	1.833	1	6.000	1
Guinobatan No. 1	3.650	1	3.750	1	25.500	1
Hawaii	7.233	1	9.461	1	11.147	1
Jersey Red	4.229	2	4.402	2	9.779	2
Jersey	4.216	1	4.881	1	5.269	1
Kinalamias	1.662	1	6.847	1	10.039	1
Lapugao	4.991	1	6.106	1	4.232	1
Longan	2.660	1	7.488	1	9.716	1
Mintal	3.032	2	4.263	2	4.411	2
Pitay	1.422	1	6.800	1	10.409	1
Processana	6.940	1	6.098	1	8.342	1
Samar Big Yellow	9.675	4	11.582	4	13.029	4
Sealey	2.409	3	7.547	3	16.678	3
Tarlac No. 1	5.026	1	10.343	1	11.686	1
Tato No. 1	6.112	1	7.201	1	10.022	1
Unnamed variety	3.147	1	5.164	1	6.451	1
Total	78.113	25	144.786	25	186.004	25
Average	4.340	1.39	8.044	1.39	10.334	1.39

Among the three sectional cuttings tested the apical cuttings lead in productions in all the tests made with the exception of the Chinese and the Lapugao varieties where the middle cuttings outyielded the former. And also the base cuttings of the Georgia Yellow Yam and the Processana outyielded the middle cuttings of the same variety in the test. Considering the average

yield of the varieties tested the apical cuttings gave 12.45 per cent more yield than the middle cuttings, and in turn the middle cuttings yielded 32.53 per cent more than the base cuttings. Furthermore, it was also noticed that the apical cuttings started growing much earlier than either the base or the middle cuttings. Esguera(7) obtained similar results for the tip cuttings of camote grew the fastest and gave the highest yields as follows: The tip cuttings yielded 17 per cent more than the middle cuttings and the latter 6.8 per cent over the base cuttings; or an actual yield of 174.8 kilos of tubers for the tip portions, 124 kilos for the middle portions, and 108.2 kilos for the base portions. Identical results were obtained from the different varieties during the course of the experiment under review. The results, therefore, conclusively demonstrated that the apical cuttings are to be preferred for planting camote veins; hence, they are here recommended. The next choice, of course, are the middle portions of the vines if not enough tips are obtainable for planting, since they ranked next in yield to the apical cuttings. *The base cuttings should not be used at all in planting the camote vines.*

DISTANCE OF PLANTING

Another factor that affects the yield of a crop is the distance of planting. Oftentimes many of our farmers overlook this important point in planting both annual and perennial crops, and they set the plants either too close or too wide apart. In the former case there is difficulty in cultivating and their consequent overcrowding of the plants—roots, branches, and leaves—resulting finally in a poor yield. On the other hand if planted too wide apart there is a waste of land, which also results in a lowering of yield per unit area. In various sections of the Islands different distances are employed for camotes. Just which of these distances will give the best yield can only be determined by actual test. Therefore a distance of planting test of camote when all field conditions were good was undertaken at the Lamao Experimental Station, Lamao, Bataan. The first two trials were performed in connection with the variety test, but it was deemed advisable to carry it on separately in order to obtain a more accurate results in the subsequent tests, using fewer and fewer varieties at a time.

In the first trial only two distances were tried. They were 1 by 1 meter and 1 by 0.6 meters apart. In subsequent tests, the distances were 1 by 0.4 meter, 1 by 0.6 meter, and 1 by 0.8 meter

each way. In all cases, 1 meter represents the distance between the rows and 0.4, 0.6 and 0.8 meter represent the distances between the plants in the rows. The table below gives the results of this experiment.

TABLE IV.—*Distance of planting test*

Year	Number of varieties tested	Computed yields at different distance in tons of tubers per hectare			
		1 by 1 meter	1 by 0.8 meter	1 by 0.6 meter	1 by 0.4 meter
1922–23	11	1.522	.....	1.412	.....
1923–24	30	.....	0.180	0.165	0.189
1924–25	8	.....	4.863	7.005	9.624
1925–26	2	.....	17.227	10.918	4.596
1926–27	2	.....	4.996	6.673	8.383
1927–28	2	.....	1.020	1.287	1.520
Total	55	1.522	28.286	27.460	24.312
Average	9.16	1.522	5.657	4.577	4.862

The 1922–1923 culture of the distance of planting test was planted October 3, 1922, in a plot of 50 square meters replicated twice, one in furrows and the other in ridges. The crops were harvested in May and June, 1923. The plants distanced one meter each way yielded more than those set out 1 by 0.6 meter apart. On this test vartiety Toguicao, Tarlac No. 2, Samar Big Yellow, Tabao, Shanghai, Blo., Guinobatan Nos. 1 and 2, Linoco, Los Baños No. 1, and Sealey were planted, and the Jersey Red camote was used as a check.

In the 1923–1924 test when thirty varieties, namely, Lapugao, American Large White, Tarlac Nos. 1, 2, 3, 4, and 5, Pattoke, Canegro, Hawaii, Jersey Red, Los Baños Nos. 1, 2, and 3, American White, Sealey, Guinobatan Nos. 1 and 2, Tato Nos. 1 and 2, Linoco, Samar Big Yellow, Toguidao, Tabao, Georgia Yellow Yam, Mintal, Blo. Nos. 38 and 98, Camarinay and Shanghai, were used the distance of 1 by 0.4 meter apart gave a slightly higher average yield than either the 1 by 0.8 or 1 by 0.6 meter apart. Planting was done May and June, 1923 in a plot of 144 square meters replicated twice, one in furrows and the other in ridges. The crops were harvested in January and February, 1924.

In 1924 using Canegro, Jersey Red, Tarlac Nos. 2 and 3, Jersey, Los Baños No. 3, Linoco and Samar Big Yellow varieties of camotes, the plants distanced 1 by 0.4 meter apart gave 15.75 per cent more yield than the 1 by 0.6 meter, while the latter yielded about 18.04 per cent more than the 1 by 0.8 meter distance.

Planting was done April, 1924, and the crops were harvested December, 1924. Each variety occupied a plot of 50 square meters, and this was replicated twice, one in ridges and the other in furrows.

In 1925 only two varieties of camotes, the Samar Big Yellow and the Sealey, were tested. Planting was done July, 1925 in a 260.4 square meters plot, replicated twice both in furrow and in ridge plantings. The crops were harvested in January, 1926, and 1 by 0.8 meter apart gave the highest production per hectare, or 22.41 and 57.88 per cent over the 1 by 0.6 and 1 by 0.4 meter distances, respectively. This was a very favorable year for planting camotes at the Lamao Experiment Station, Lamao, Bataan.

Of the two varieties, the Samar Big Yellow and the Mintal, tested in 1926, the distance of 1 by 0.4 meter apart yielded 11.33 per cent more than the 1 by 0.6 meter, and on the other hand the latter distance produced 14.45 per cent more than the 1 by 0.8 meter distance. Planting was made both in ridges and in furrows on September 15, 1926, in duplicated plots of 90 square meters each. The crops were harvested in February, 1927.

In 1927, Samar Big Yellow and Mintal camotes were used in this test. Planting was made in a 150 square meters plot on September 30–31, 1927. This was duplicated twice, one in furrows and the other in ridges. The crops were harvested in January, 1928. As in previous year the distance of 1 by 0.4 meter produced a better average yield than either the two distances, 1 by 0.8 and 1 by 0.6 meter apart.

A six-year distance of planting test showed that the distance of 1 by 0.8 meter apart produced 10.55 and 7.55 per cent more yields than the 1 by 0.6 and 1 by 0.4 meter distances, respectively. However, the five-year tests from 1923 to 1927 with the exception of that in 1925 showed greater yields at a closer distance, 1 by 0.4 meter apart. This experiment indicates that camote vines planted during the rainy season or under such good climatic conditions as that of the 1925 culture a wider spacing is necessary in order to obtain the maximum production per unit area, and when planted under adverse climatic conditions or during the dry season 1 by 0.4 meter apart is a sufficient distance for the camote vines as shown from the results of the 1923, 1924, 1926, and 1927 cultures of this crop. During these years the distance of 1 by 0.4 meter apart outyielded the 1 by 0.6 and 1 by 0.8 meter distances by 13.15 and 22.32 per cent, respectively.

RIDGE AND FURROW PLANTING OF SWEET POTATOES

The object of this experiment was to determine which of the two methods of planting, namely, ridge and furrow, will give a better yield. From the first tests, consisting of 12 varieties planted in furrows of 1 by 1 meter apart Merino(5) obtained an average yield of 12.887 tons of tubers per hectare, and 13.877 tons from the second test consisting of nine varieties, or with a general average of 13.382 tons to the hectare. And of the eight varieties planted in ridges 1 meter by 18 inches apart an average yield of 10.866 tons to the hectare was produced from the first test and 8.96 tons from the second test consisting of seven varieties distanced 1 m. by 36 inches apart, or with a general average of 9.913 tons to the hectare. Muñoz(6) reported the following yields of ridge versus flat planting of camotes:

Variety	In tons of tubers per hectare	
	In ridges	In furrows
Manila Red	8.926	8.594
Samar Big Yellow	6.804	5.140
Beattie	6.609	7.910
Average	7.448	7.215

The results of the six-year tests at the Lamao Experiment Station, Lamao, Bataan, are tabulated below.

TABLE V.—*Ridge versus Furrow Planting of sweet potatoes*

Number of varieties tested	Year tested	Computed yield in tons of tubers per hectare	
		In ridges	In furrows
Eleven varieties	1922–3	1.377	1.487
Twenty-six varieties	1923–4	1.653	1.133
Eight varieties	1924–5	7.305	7.081
Two varieties	1925–6	6.144	4.161
Two varieties	1926–7	8.014	6.017
Two varieties	1927–8	1.210	0.686
Total	6	25.703	20.565
Average		4.451	3.428

This experiment was replicated three times with the exception of the first year trial wherein only two replications were made because of lack of planting materials. The distance used as 1 by 0.8 meter apart in 1922, and all subsequent tests were distanced 1 by 0.6 meter.

Uniform results were obtained from the ridge versus furrow planting, that is, the ridge planting produced better yields throughout the test than the furrow planting excepting on the first trial in 1922. However, taking the average production of the six-year trials proved that the ridge method is better than the furrow system. The ridge method yielded axpproximately 13 per cent over the furrow planting. In planting camotes by the ridge system, however, the cost of labor in preparing the ridges should be taken into considerations since to prepare the ground in ridges is more expensive than to make the furrows. If the increase of yield that may be expected from the ridge system and the corresponding market value of the crop will not repay the investment in building the ridges then furrow planting should be resorted to.

In 1922 eleven varieties, namely, Toguicao, Tarlac No. 2, Samar Big Yellow, Tabao, Shanghai, Blo. No. 98, Guinobatan Nos. 1 and 2, Linoco, Los Baños No. 1 and Sealey were planted in a 100 square meters individual plot on October, 1922. In 1923, 26 varieties of sweet potatoes were tried in a 432 square meters plot for each replication. Planting this year was done in May and June and the crops were harvested nine months after planting. In 1924 the varieties Canegro, Jersey Red, Tarlac No. 3, Jersey, Los Baños No. 3, Linoco, Samar Big Yellow and Tarlac No. 2 were planted April, 1924 for this test in a 100 square meters plot for each replication. Harvesting was done December, 1924, and some of the varieties responded well on ridge while others on furrow planting.

The Samar Big Yellow and Sealey varieties of camotes were used during the year 1925. Planting was done July, 1925, in an area of 260.4 square meters plot. The crops were harvested January, 1926, and the results showed that the ridge yielded 19.24 per cent more than the furrow system. The Samar Big Yellow planted in ridges yielded 8.85 tons against 5.870 tons to the hectare of the furrow planting, while the Sealey variety gave 3.438 against 2.452 tons.

The result in 1926 showed that both the Samar Big Yellow and the Mintal produced higher yields from the ridge planting. The same varieties were used in 1927, and this year planting was done October 1, 1927. Each variety occupied an area of 200 square meters. Again, this year's result showed that the ridge exceeded the furrow method in production per hectare.

STORAGE OF SWEET POTATO TUBERS

Unlike most perishable products the sweet potato tubers require a warm and dry atmosphere while in storage. Since we lack the necessary storage chamber where the temperature could be controlled for storing the camote tubers four set of conditions were tried, as follows:

(1) In a trench of 6 by 1 by 2.5 feet dug in a shaded place. The trench was previously filled with water and allowed to dry for five days before storing the tubers.

(2) In a pit of 1 by 1 by 1 meter dug in a shaded place near the bank of a running creek.

(3) In a heap where tubers were piled on top of each other above the surface of the ground and covered with layers of dry banana leaves and soil as in the case of the trench and the pit methods of storage.

(4) In sand wherein the tubers were placed in a cylindrical tin can of about one-half meter in diameter and about 1½ meters high and every layer of tubers covered with a 2-inch layer of sand. This alternate layering of sand and camote tubers was continued until all the tubers to be experimented with were stored with sand at the topmost layer.

(5) A check or control was provided. In this case the camote tubers were kept on shelves under ordinary room temperature in the bodega.

Sound tubers having a uniform size and free from injury were selected for this experiment, and before storing them they were first kept on a well ventilated shelf at room temperature in the bodega for one and one-half weeks. The tubers used in the first trial were of two lots, consisting of tubers dug at two weeks before and newly harvested ones, while in the succeeding trials only the former kind were employed.

A 6-inch bedding of dry leaves were laid over the surface of the trench and pit before putting in the tubers, then alternate layers of dry banana leaves and soil were used to cover the tubers. A similar treatment was given in the heap method. Under each of these three set of conditions a bamboo pipe about 6 centimeters in diameter and 2 meters long was inserted in an inclined position through the coverings and at the middle of the pile of tubers for ventilation purposes.

The number of decayed tubers were taken monthly and the summary of the results are given in Table VI.

TABLE VI.—*Storage of sweet potato tubers*

Method	Number of tubers stored	Number of trials	First observation		Second observation		Total of decayed tubers	
			Rotted tubers	Per cent	Rotted tubers	Per cent	Number	Per cent
In trench	722	5	149	20.64	345	47.78	494	68.42
In pit	799	5	111	13.89	279	34.92	390	48.81
In heap	726	5	285	39.26	299	41.18	584	80.44
In sand	350	2	25	7.14	95	27.14	120	34.28
Control	330	3	282	85.45	41	12.42	323	97.87

There was not much difference in the keeping quality between the newly harvested tubers and those that had been harvested two weeks before, so that in the preceding trials only two-week old tubers were used. After three months of storage all remaining tubers were found decayed, and therefore no material benefit was derived by storing camote tubers under any of these conditions for more than two months. The experiment pointed out also that the pit and the sand storage methods kept the tubers in good conditions for two months with a less percentage of decay. However, the sand hastened the germination of the stored tubers more than the pit system, which is the great disadvantage of this method. Recapitulating the results of all the trials, it may be said that under the sand and the pit methods only 34.28 and 48.81 per cent of the tubers were decayed, respectively, after two months of storage against 68.42 per cent for the trench, 80.44 per cent for the heap and 97.87 per cent for the control tubers.

CONCLUSIONS

1. Of the 42 varieties or strains of camotes subjected to the variety test the highest yielding varieties are the Momungan, Mintal, Canegro, and American White.

2. For planting the camote vines, both in growth and yields, the apical cuttings are the best planting materials.

3. A wider distance is necessary in planting camote vines under favorable season, and during the dry season 1 by 0.4 meter apart is sufficient for the camote vines.

4. Ridge planting has proved better than the furrow system in planting the camote vines, but the cost of preparing the ridges is much greater than for making the furrows.

5. Of the different conditions tried in storing the camote tubers the pit was found the best.

REFERENCES

1. T. B. McCleland: Report of the Horticulturist, Porto Rico Agricultural Experiment Station, 1924, pp. 11–14.
2. F. Watts: Report of Field Crops Work in British Virgin Islands for 1918–19, U. S. Department of Agriculture Experiment Station Record, Vol. 42, 1920, pp. 230.
3. F. Watts: Work with Field Crops in 1915–16 at the St. Kitts-Nevis Experiment Station, U. S. Department of Agriculture Experiment Station Record, Vol. 38, 1918, pp. 33.
4. ——— Pennsylvania Agricultural Experiment Station, U. S. Department of Agriculture Experiment Station Record, Vol. 23, 1910, pp. 334.
5. Gonzalo Flor de Liza Merino: Field Tests of Sweet Potatoes, The Philippine Agriculturist and Forester, Vol. 3, 1914, No. 6, pp. 146–156.
6. Apolonio Ramos Muñoz: Identification and Tests of Varieties of Sweet Potatoes, The Philippine Agriculturist and Forester, Vol. 3, 1914, No. 6, pp. 127–145.

A RAPID MODIFIED METHOD OF DETECTING AND ESTIMATING HYDROCYANIC ACID SUITABLE FOR FIELD TESTS

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TWO PLATES

Autenrieth (1921) gives a number of qualitative and quantitative methods for the detection and determination of hydrocyanic acid, but no method has been found suitable for field testing of this compound for such samples as roots and tubers. In the breeding and selection of special varieties of tubers, where individual tests have to be made by the hundreds and thousands within a short period of time to determine their hydrocyanic acid content, there is need for a short method which will not only detect this compound but which will also give a more or less quantitative measure of this poisonous substance.

It is therefore the object of this paper to report the results of devising a modified method which will satisfy the above requirements.

Based on Guignard's (1916) procedure, an approximate quantitative method was devised, by using the intensity and length of coloration which a given definite amount of hydrocyanic acid will give on especially prepared picric acid paper.

PREPARATION OF STANDARD PICRIC ACID STAIN PAPER

Uniform strips of filter paper measuring 20 by 0.50 centimeters were immersed in 1:1 mixture of 10 per cent C.P. sodium carbonate and one per cent C.P. picric acid solutions for about 10 minutes. The strips were then placed in an electric oven kept at 60° C. When almost dry, they were removed and placed in a long test tube which was corked tightly to prevent the strips from drying completely.

A standard solution of potassium cyanide was prepared from the pure salt.[2] The apparatus shown in Figure 1 was devised

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[2] One cubic centimeter of the stock solution contains 0.5 milligram KON.

and then carefully set. By means of a special burrette 0.1, 0.2, 0.3, . . . etc. cubic centimeter of the potassium cyanide stock solution was separately measured into the bulb (*B*). Then 5 to 10 cubic centimeters distilled water were added. A strip of the prepared picric acid paper (*P*) was suspended from the cork (*C*) as shown in the figure. The heat was generated. After cooling the contents of (*B*), the strip (*P*) was removed and then immersed momentarily in melted paraffin so as to give the strip of picric acid paper a very thin coating of paraffin. The above procedure was followed using different volumes of potassium cyanide solution. A series of stained picric acid paper was obtained as shown in plate 1. These served as the standards.

METHOD

With the use of a one-half inch cork borer, cylindrical strips ranging from three-eights to six-eigths inch long of fresh tubers of name, *Dioscorea hispida* Dennstedt, and cassava, *Manihot utilissima* Pohl., were weighed. The average weight of varying lengths of the cylindrical strips of the samples are given in Table 1. For other samples of tubers and root crops a similar table can be easily prepared. The sample is to be chopped very fine and then placed in the bulb (*B*). Sufficient water is to be added to cover the whole and heat then applied gently. When the first bubble appears the flame is to be withdrawn for about 5 minutes in order to allow the hydrolysis of the glucoside to proceed. Then heat is again applied until all the hydroyanic acid is evolved. This operation usually takes about 5 minutes. The contents of the bulb (*B*) are cooled and the strip of paper (*P*) is removed. The latter is immersed in melted paraffin momentarily. Comparing the intensity of stain of this strip with that of the standards, and using the average weight of sample taken from Table 1, the amount of hydrocyanic acid in the sample is calculated.

This proposed method, which requires only simple field test equipment, is very rapid and gives results comparable with the older methods which require more complicated apparatus and a longer time for hydrolysis. Table 2 gives the comparative results of the proposed and older methods of determining hydrocyanic acid.

LITERATURE CITED

1. Anonymous. 1925. Official and tentative methods of analysis. 2nd ed. iii + 535 pp. Washington, D. C., American Association of Official Agricultural Chemists.

2. AUTENRIETH, W. (Translated by W. H. Warren.) 1921. Laboratory manual for the detection of poisons and powerful drugs. 5th ed. 432 pp. *Figs. 1–25.* Philadelphia, Pa.: P. Blackiston's Sons and Co.
3. GUIGNARD, L. 1916. The detection and estimation of hydrocyanic acid in beans. Ann. Falsif. 9: 301–305. Cited in Chemical abstracts. 1927. 11: 674.
4. FRANCIS, C. K. and CONNELL, W. B. 1913. The colorimetric method for determining hydrocyanic acid in plants with special reference to kaffir corn. 1913. Journal of the American Chemical Society 35: 1624–1628.
5. MENAUL, P. and DOWELL, C. T. 1920. Cyanogenesis in sudan grass: modification of the Francis-Connell method of determining hydrocyanic acid. Journal of Agricultural Research 18: 447–450.
6. WILLIAM, J. J. and WEST, R. M. 1915. Notes on the hydrocyanic acid content of sorghum. Journal of Agricultural Research 4: 179–186.

TABLE 1.—*Average weight of cylindrical strips of fresh namé and cassava tubers of varying lengths obtained by means of a one-half inch cork borer.*

Length of strip	Average weight of namé strip [1]	Average weight of cassava strip [1]	Length of strip	Average weight of namé strip	Average weight of cassava strip
Inch	*Grams*	*Grams*	*Inch*	*Grams*	*Grams*
[illegible]	1.1	1.1	[illegible]	1.9	1.9
[illegible]	1.5	1.5	[illegible]	2.2	2.2

[1] Average of ten separate determinations.

TABLE 2.—*Showing the comparative results of determining hydrocyanic acid in namé and cassava tubers obtained with the use of the proposed and the older methods.*[5]

Sample	Francis-Connell method modified by Menaul and Dowell [2]	Francis-Connell method modified by Willaman and West [3]	The proposed method [4]
	Per cent	*Per cent*	*Per cent*
Namé (treated) [6]	0.006	0.005	0.005
Namé (untreated) hairy variety	0.154	0.155	0.150
Namé (untreated) non-hairy variety	0.137	0.124	0.130
Cassava (Casjave Singkong Manis variety)	0.023	0.019	0.018
Cassava (Rough Intermediate variety)	0.016	0.015	0.018
Cassava (Aguilar variety)	0.017	0.017	0.018

[2] Twelve hours hydrolysis.
[3] Two hours hydrolysis.
[4] Five minutes hydrolysis.
[5] The methods given in the official and tentative methods of analysis (1925) were tried but were found to be unsatisfactory.
[6] Soaked in water to remove hydrocyanic acid.

ILLUSTRATIONS

PLATE I. An assembly of the apparatus for the rapid detection and estimation of the quantity of hydrocyanic acid in roots and tubers.

II. Stain standards for the rapid detection and estimation of hydrocyanic acid.

1 ..... 0.12 milligrams HCN
2 ..... 0.10 milligrams HCN
3 ..... 0.08 milligrams HCN
4 ..... 0.06 milligrams HCN
5 ..... 0.04 milligrams HCN
6 ..... 0.02 milligrams HCN
7 ..... Blank

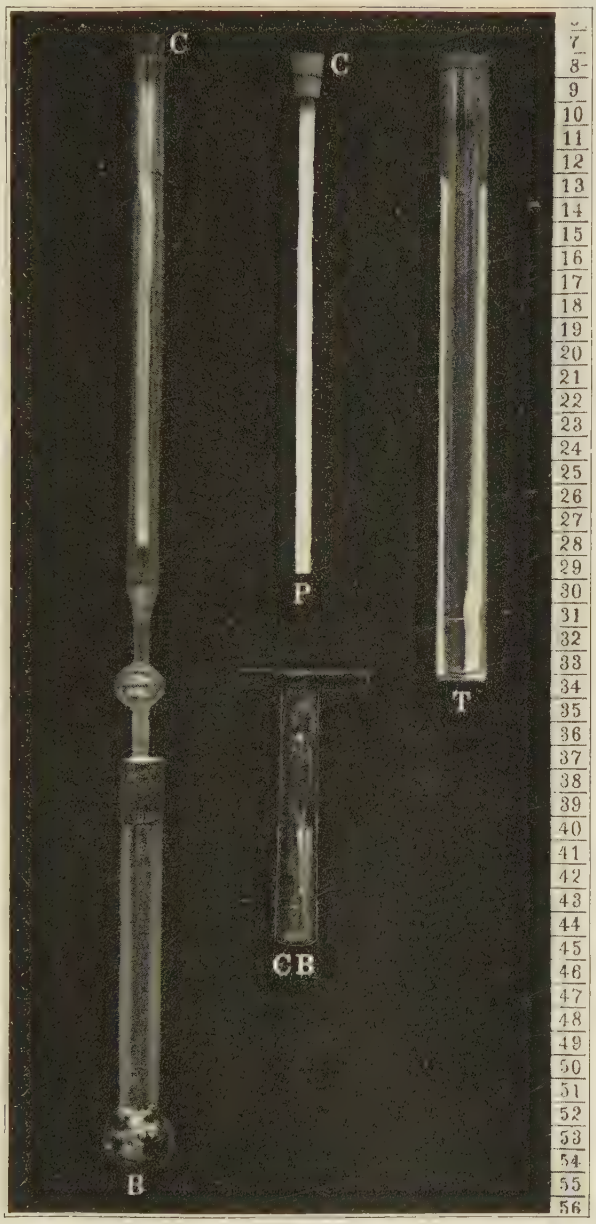

PLATE I. An assembly of the apparatus for the rapid detection and estimation of the quantity hydrocyanic acid in roots and tubers

B—bulb of the distillation tube.
C—cork to hold the picric acid stained paper.
P—picric acid stained paper.
CB—cork borer ½ inch diameter.
T—specially made test tube for keeping the picric acid stained papers.

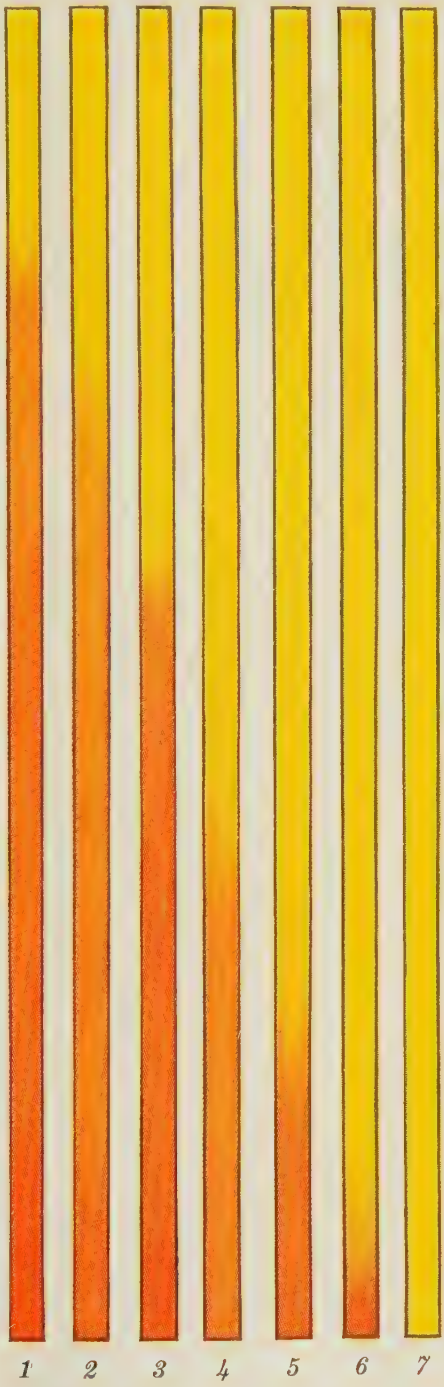

PLATE II. Stain standards for the rapid detection and estimation of hydrocyanic acid

1——0.12 milligrams HCN
2——0.10 milligrams HCN
3——0.08 milligrams HCN
4——0.06 milligrams HCN
5——0.04 milligrams HCN
6——0.02 milligrams HCN
7——Blank

MANGO INVESTIGATIONS IN MUNTINLUPA, RIZAL

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HISTORY

The establishment of mango plantations in Muntinlupa, Rizal, as told by men who planted the seeds in the nursery at that time began in the years 1892 to 1894. The laying out of the plantations was under the management of Fray Casildo Caballero, a Spaniard of the Franciscan Order. He bought the seeds from boys at from one to two cuarta (Mex)[a] regardless of the variety, for it was hard to determine when seeds came from different localities.

There are two plantations. One is located on the plain portion called La Huerta situated in the barrio of Tunasan near lake Laguna at Muntinlupa and is crossed by the South Manila Railroad line. The trees were planted on the square system. The other plantation is located on the hill sides on the west side of the interprovincial road, Manila–Calamba. The rows were distanced at most 26 meters apart and there are gaps where there are no signs of planting. The rows run from north to south with few exceptions. The trees were planted as close as 5 meters apart with the possible object of thinning them out later. As a result of this far too close spacing, stunted and deformed trees are not uncommon.

CLIMATE AND SOILS

Table I

Year	Average monthly temperature		Average monthly relative humidity		Total rainfall	Number of rainy days
	Maximum	Minimum	6 a. m.	2 p. m.		
	°C.	°C.			mm.	
1925	30.90	19.50	90.75	71.75	1,834.6	74
1926	31.16	22.16	88.66	68.75	1,256.7	125
1927	31.49	23.60	90.25	71.00	1,766.7	106

Table II.—*Showing physical character of soils*

	Topography	Average depth of surface soil	Nature of subsoil	Avarage elevation
		Cm.		Meters
Plantation No. 1	Plain-rolling	15.40	From claystone to loam.	33.75
Plantation No. 2	Rolling	10.11	Claystone	39.00
Non-mango region	Plain-rolling	15.33	From claysand to clayloam.	31.00

[a] One Mexican peso equals 160 cuartas

TABLE III.—*Showing the average chemical analysis of soils from different plantations including non-mango regions*

	Plantation No. 1	Plantation No. 2	Non-mango region[a]
	Per cent	*Per cent*	*Per cent*
Loss on ignition	8.32	10.01	6.69
Nitrogen	.113	.151	.121
Phosphoric anhydride	.167	.259	.274
Calcium oxide	3.30	2.19	3.95
Potash	.484	.536	.975
Humus	1.01	1.13	.89
Soil acidity	.011	.012	.011

[a] Average chemical analysis of soil samples taken from Poblacion and nearby barrios of Putatan and Sucat.

The soil in the non-mango region is underlaid with conglomerate rocks possibly of volcanic origin and in some places soils are transported sandy loams.

MATERIALS AND METHOD

There are four varieties found in the plantation: Carabao, Pico, Señora, and Pahutan mangoes. For study and for commercial purposes, only the varieties Carabao and Pico were selected as materials.

Girth of trunk, height of trees, spread of crown, distance in the rows and distance of rows were investigated in Plantations Nos. 1 and 2. For the study of girth of trunks, height of trees, and spread of crowns 64 trees were taken in Plantation No. 1 and 66 trees in Plantation No. 2; for the study of tree spacing in the row, 48 trees were taken in Plantation No. 1 and 72 in Plantation No. 2 and trees with spacing of less than 9 meters in the row were eliminated and for the study of distance of rows, ten rows were taken in Plantation No. 1 and no study of distance of rows was made in Plantation No. 2, for there were several gaps in the plantation where a certain number of rows was not available. Studies were made also on the effect of smudging on the Carabao and Pico varieties; comparative yields and weights of fruits of respective varieties produced, due to smudging and comparative weights of fruits of the two varieties produced due to smudging and of fruits of regular season crop.

Smudging.—The literal definition for smudging is a suffocating smoke produced by a low-burning bonfire. This is accomplished by igniting a pile of dried materials. For the best results the pile of dried materials when starting to burn is

covered with fresh leaves or trash on top in order to furnish a dense smoke. It is kept up from morning to late in the evening.

Investigation on the effects of smudging to cause mango trees to fruit was conducted in a block of a mango plantation in Tunasancillo in Muntinlupa, Rizal, within Plantation No. 1. The trees were 27 years old at the time when the study was made and spaced on an average of 13 meters square. There were 95 trees occupying an area 2.4 hectares.

Smudges were built at different places in the plantation at varying distances, 1 to 8 meters from the tree, or a general average of 8 meters. Due to the prevailing wind in November ESE direction, smudges were placed in that direction so as to have a direct effect on the trees treated. For every four trees three smudges were provided. Out of the 95 trees treated, 80 produced flowers or 84 per cent. Buds were formed in eight days in the majority of cases, nine days or more for a less number of trees and seven days for a smaller number. The greatest distance of the tree affected from the smudge was 60 meters. It is believed that it is not the direct heating of the tree and the ground as well under which the roots are located but the smoke that suffocates the tree and induces it to flower. An almost similar incident occurred in Malolos, Pulilan, and Quingua in the Province of Bulacan, where smudges were built in the middle top of tall trees that could not be reached by smoke from the ground on account of the action of the wind. In this particular case the action of heat on the ground under which the roots are was absent. Trees that do not flower by the fourteenth day of continuous smudging will not flower at all that season. This is especially true when the twigs and leaves are less than a year old.

After all the buds had emerged and grown to about 5 centimeters in length, smudging was discontinued. Young leaf buds may be mistaken for flower buds but the difference is that the leaf buds develop quicker and in three to five days distinct leaves form whereas flower buds are slow to develop and do not form distinct leaves at all. It takes two weeks from emergence of the flower buds to pollination. Pollination takes place when the flowers are fragrant.

Smudging mango trees, according to investigations made, may be done as early as November and as late as January. Smudging during November causes only a few fruits to develop, due to prevalent pests and diseases. Those that are smudged in

December give satisfactory result, while those that are forced to flower in January give the best returns.

The fruits matured in a little less than five months from bud formation. When the fruits present an external white powdery appearance and slight yellow color at the basal portion, they are matured, ready for harvesting.

Harvesting.—Picking of fruits is done late in the morning when the dew in the leaves and fruits has dried up. Harvesting is done by picking the fruits with the use of a circular net with a bamboo handle of convenient size especially made for the purpose. The fruits collected in the net are transferred to a basket provided with a long rope tied to it to facilitate lowering the fruit to the ground. A fruit tender attends to the transferring of the fruits from the basket to the ground with a thick bedding of soft leaves to save the fruit from being bruised. The basal portions of the fruits are placed downward to permit further flowing of the latex. Care is taken in handling the fruits to retain the white powdery material to give an attractive appearance when ripe.

The fruits thus dried of latex are transferred to baskets called "kaing," with sufficient bedding of dried banana leaves at the bottom and a slight covering of the same on top of the fruits up to the brim and covered with board for transport.

The following tables present the results obtained from the investigation:

TABLE IV.—*Showing girth of trunk in Plantation No. 1 (centimeters)*

V	f	Vf	D	D^2	D^2f
85	1	85	—170.08	28,913.61	28,913.61
90	0				
95	1	95	—160.08	25,625.61	25,625.61
100	0				
105	0				
110	0				
115	0				
120	0				
125	0				
130	0				
135	0				
140	0				
145	0				
150	0				
155	0				
160	2	320	— 95.08	9,040.21	18,080.42
165	0				
170	1	170	— 85.08	7,238.61	7,238.61
176	0				
180	1	180	— 75.08	5,637.01	5,637.01
185	1	185	— 70.08	4,911.21	4,911.21
195	0				
200	4	800	— 55.08	3,033.81	12,135.24
205	3	615	— 50.08	2,508.01	7,524.03
210	1	210	— 45.08	2,032.21	2,032.21
215	2	430	— 40.08	1,606.41	3,212.82
220	2	440	— 35.08	1,230.61	2,461.22

TABLE IV.—*Showing girth of trunk in Plantation No. 1 (centimeters)*—Ctd.

V	f	Vf	D	D^2	D^2f
225	3	675	— 30.08	904.81	2,714.43
230	3	690	— 25.08	629.01	1,887.03
235	3	705	— 20.08	403.21	1,209.63
240	2	480	— 15.08	227.41	454.82
245	6	1,470	— 10.08	101.61	609.66
250	0				
255	2	510	— 0.08	0.01	0.02
260	6	1,560	+ 4.92	24.21	145.26
265	2	530	+ 9.92	98.41	196.82
270	1	270	+ 14.92	222.61	222.61
275	1	275	+ 19.92	396.80	396.80
280	0				
285	1	285	+ 29.92	895.20	895.20
290	0				
295	0				
300	2	600	+ 44.92	2,017.81	4,035.62
305	1	305	+ 49.92	2,492.00	2,492.00
310	1	310	+ 54.92	3,016.20	3,016.20
315	0				
320	2	640	+ 64.92	4,214.61	8,429.22
325	1	325	+ 69.92	4,888.80	4,888.80
330	1	330	+ 74.92	5,613.00	5,613.00
335	2	670	+ 79.92	6,387.21	12,774.42
340	0				
345	0				
350	0				
355	0				
360	0				
365	0				
370	0				
375	0				
380	0				
385	0				
390	0				
395	0				
400	1	400	+144.92	20,995.80	28,995.80
405	0				
410	0				
415	0				
420	2	840	+164.92	27,198.61	108,796.80
425	0				
430	1	430	+174.92	30,597.00	30,597.00
435	0				
440	0				
445	0				
450	0				
455	0				
460	0				
465	0				
470	0				
475	0				
480	0				
485	0				
490	0				
495	1	495	+239.92	57,561.60	57,561.60

$n = 64 \qquad \Sigma Vf = 16325$

$$M = \frac{\Sigma Vf}{n}$$

$$= 255.08 \pm 6.55$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{77.63}{\sqrt{64}}$$

$$= \pm 6.55$$

$$\acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = 385704.62$$

$$= \sqrt{\frac{385704.62}{64}}$$

$$= 77.63$$

TABLE V.—*Showing height of trees in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
7.0	1	7.0	—4.0	24.01	24.01
7.5	0				
8.0	0				
8.5	1	8.5	—3.4	11.56	11.56
9.0	4	36.0	—2.9	8.41	33.64
9.5	4	38.0	—2.4	5.76	23.04
10.0	4	40.0	—1.9	3.61	14.44
10.5	5	52.5	—1.4	1.96	9.80
11.0	6	66.0	—0.9	.81	4.86
11.5	4	46.0	—0.4	.16	.64
12.0	4	48.0	+0.1	.01	.04
12.5	10	125.0	+0.6	.36	3.60
13.0	6	78.0	+1.1	1.21	7.26
13.5	5	67.5	+1.6	2.56	12.80
14.0	3	42.0	+2.1	4.41	13.23
14.5	2	29.0	+2.6	6.76	13.52
15.0	0				
15.5	3	46.5	+3.6	12.96	38.88
16.0	1	16.0	+4.1	16.81	16.81
16.5	0				
17.0	1	17.0	+5.1	26.01	26.01

$n = 64$ $\quad \Sigma Vf = 763$ $\quad \Sigma D^2f = 254.14$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{763}{64}$$

$$= 11.90 \pm 0.16$$

$$\sigma = V\frac{\Sigma D^2f}{n}$$

$$= V\frac{254.14}{64}$$

$$= 1.90$$

$$P.E._m = \pm 0.6745\frac{\sigma}{Vn}$$

$$= \pm 0.6745 V\frac{1.90}{64}$$

$$= \pm 0.16$$

TABLE VI.—*Showing crown diameters (spread) in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
6.0	1	6.0	—7.0	49.00	49.00
6.5	1	6.5	—6.5	42.25	42.25
7.0	0	.....	.....	.....	.....
7.5	0	.....	.....	.....	.....
8.0	0	.....	.....	.....	.....
8.5	1	8.5	—4.5	20.25	20.25
9.0	3	27.0	—4.0	16.00	48.00
9.5	0	.....	.....	.....	.....
10.0	0	.....	.....	.....	.....
10.5	4	42.0	—2.5	6.25	25.00
11.0	2	22.0	—2.0	4.00	8.00
11.5	4	46.0	—1.5	2.25	9.00
12.0	2	24.0	—1.0	1.00	2.00
12.5	4	50.0	—0.5	.25	1.00
13.0	6	78.0	0.0	.00	.00
13.5	9	121.5	+0.5	.25	2.25
14.0	10	140.0	+1.0	1.00	10.00
14.5	7	101.5	+1.5	2.25	15.75
15.0	1	15.0	+2.0	4.00	4.00
15.5	5	77.5	+2.5	6.25	31.25
16.0	1	16.0	+3.0	9.00	9.00
16.5	2	33.0	+3.5	12.75	25.50
17.0	0	.....	.....	.....	.....
17.5	0	.....	.....	.....	.....
18.0	1	18.0	+5.0	25.00	25.00

$n = 64$ $\quad \Sigma Vf = 832.5$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 327.25$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{832.5}{64}$$

$$= 13.00 \pm 0.18$$

$$= V\frac{327.25}{64}$$

$$= 2.20$$

$$P.E._m = \pm 0.6745\frac{\acute{o}}{V n}$$

$$= \pm 0.6745\frac{2.20}{V64}$$

$$= \pm 0.18$$

TABLE VII.—*Showing distance of trees in the row in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
9.0	2	18.0	−4.6	21.16	42.32
9.5	0				
10.0	0				
10.5	0				
11.0	1	11.0	−2.6	6.76	6.76
11.5	3	34.5	−2.1	4.41	13.23
12.0	4	48.0	−1.6	2.56	10.24
12.5	2	25.0	−1.1	1.21	2.42
13.0	5	65.0	−0.6	0.36	1.80
13.5	3	40.5	−0.1	0.01	0.03
14.0	8	112.0	+0.4	0.16	1.28
14.5	12	174.0	+0.9	0.81	9.72
15.0	5	75.0	+1.4	1.96	9.80
15.5	0				
16.0	1	16.0	+2.4	5.76	5.76
16.5	0				
17.0	0				
17.5	1	17.5	+3.9	15.21	15.21
18.0	1	18.0	+4.4	19.36	19.36

$n = 48$ $\quad \Sigma Vf = 654.5$ $\quad \sigma = \sqrt{\frac{\Sigma D^2 f}{n}}$ $\quad \Sigma D^2 f = 137.93$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{654.5}{48}$$

$$= 13.60 \pm 0.16$$

$$= \sqrt{\frac{137.93}{48}}$$

$$= 1.69$$

$$P.E._m = \pm 0.6745 \frac{\sigma}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{1.69}{\sqrt{48}}$$

$$= \pm 0.16$$

TABLE VIII.—*Showing distance of rows in Plantation No. 1 (meters)*

Rows f	V	D	D^2
1–2	12.0	—1.47	2.16
2–3	15.0	+1.53	2.34
3–4	14.0	+0.53	0.28
4–5	14.2	+0.73	0.53
5–6	14.8	+1.33	1.77
6–7	15.0	+1.53	2.34
7–8	13.1	—0.37	0.14
8–9	12.2	—1.27	1.61
9–10	15.3	+1.83	3.35
10–11	Cap.		
11–12	9.1	—4.37	19.10

$n = 10$ $\quad \Sigma V = 134.7$ $\quad \acute{o} = \sqrt{\frac{\Sigma D^2}{n}}$ $\quad \Sigma D^2 = 33.62$

$$M = \frac{\Sigma V}{n}$$

$$= \frac{134.7}{10}$$

$$= 13.47 \pm 0.43$$

$$= \sqrt{\frac{33.62}{10}}$$

$$= 1.90$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \sqrt{\frac{1.90}{10}}$$

$$= \pm 0.43$$

TABLE IX.—*Showing girth of trunk of Carabao variety in Plantation No. 1 (centimeters)*

V	f	Vf	D	D^2	D^2f
85	1	85	—155.64	24,212.81	24,212.81
90	0				
95	1	95	—145.64	21,211.01	21,211.01
100	0				
105	0				
110	0				
115	0				
120	0				
125	0				
130	0				
135	0				
140	0				
145	0				
150	0				
155	0				
160	2	320	— 80.64	6,502.81	13,005.62
165	0				
170	1	170	— 70.64	4,990.01	4,990 01
175	0				
180	0				
185	1	185	— 55.64	3,095.81	3,095.81
190	0				
195	0				

TABLE IX.—*Showing girth of trunk of Carabao variety in Plantation No. 1 (centimeters)*—Continued.

V	f	Vf	D	D^2	D^2f
200	3	600	— 40.64	1,651.61	4,954.83
205	2	410	— 35.64	1,270.21	2,540.42
210	0				
215	0				
220	2	440	— 20.64	426.01	852.02
225	1	225	— 15.64	244.61	244.61
230	3	690	— 10.54	113.21	339.63
235	2	470	— 5.64	31.81	63.62
240	1	240	— 0.64	0.41	0.41
245	5	1,225	+ 4.36	19.01	95.05
250	0				
255	1	255	+ 14.36	206.21	206.21
260	2	520	+ 19.36	374.81	749.62
265	1	265	+ 24.36	593.41	593.41
270	1	270	+ 29.36	862.01	862.01
275	1	275	+ 34.36	1,180.61	1,180.61
280	0				
285	1	285	+ 44.36	1,967.81	1,967.81
290	1	290	+ 49.36	2,436.41	2,436.41
295	0				
300	1	300	+ 59.36	3,523.61	3,523.61
305	0				
310	1	310	+ 69.36	4,810.81	4,810.81
315	0				
320	1	320	+ 79.36	6,298.01	6,298.01
325	0				
330	0				
335	1	335	+ 94.36	8,903.81	8,903.81
340	0				
345	0				
350	0				
355	0				
260	0				
365	0				
370	0				
375	0				
380	0				
385	1	385	+144.36	20,839.81	20,839.81
390	0				
395	0				
400	0				
405	0				
410	0				
415	0				
420	1	420	+179.36	32,170.01	32,170.01

$n = 39 \qquad \Sigma Vf = 9385 \qquad \sigma = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = 160147.16$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{9385}{39}$$

$$= 240.64 \pm 7.20$$

$$\sigma = \sqrt{\frac{160147.19}{39}}$$

$$= 64.08$$

$$P.E._m = \pm 0.6745 \frac{\sigma}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{64.08}{\sqrt{39}}$$

$$= \pm 7.20$$

TABLE X.—*Showing height of tree of Carabao variety in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
7.0	1	7.0	—4.45	19.80	19.80
7.5	0				
8.0	0				
8.5	1	8.5	—2.95	8.70	8.70
9.0	2	18.0	—2.45	6.00	12.00
9.5	4	38.0	—1.95	3.80	15.20
10.0	1	10.0	—1.45	2.10	2.10
10.5	5	52.5	—0.95	0.90	4.50
11.0	5	55.0	—0.45	.20	1.00
11.5	2	23.0	+0.05	.00	.00
12.0	3	36.0	+0.55	.30	.90
12.5	7	87.5	+1.05	1.10	7.70
13.0	3	39.0	+1.55	2.40	7.20
13.5	2	27.0	+2.05	4.20	8.40
14.0	1	14.0	+2.55	6.50	6.50
14.5	0				
15.0	0				
15.5	2	31.0	+4.05	16.40	32.80

$n = 39 \qquad \Sigma Vf = 446.50 \qquad \Sigma D^2f = 126.80$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{446.50}{39}$$

$$= 11.45 \pm 0.20$$

$$\text{ó} = \sqrt{\frac{\Sigma D^2f}{n}}$$

$$= \sqrt{\frac{126.80}{39}}$$

$$= 1.80$$

$$\text{P.E.}_m = \pm 0.6745 \frac{\text{ó}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{1.80}{\sqrt{39}}$$

$$= \pm 0.20$$

TABLE XI.—*Showing spread of crown of Carabao variety in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
6.0	1	6.0	—6.52	42.51	42.51
6.5	1	6.5	—6.02	26.24	26.24
7.0	0				
7.5	0				
8.0	0				
8.5	1	8.5	—4.02	16.16	16.16
9.0	2	18.0	—3.52	12.39	24.78
9.5	0				
10.0	0				
10.5	3	31.5	—2.02	4.08	12.24
11.0	2	22.0	—1.52	2.31	4.62
11.5	3	34.5	—1.02	1.04	3.12
12.0	2	24.0	—0.52	0.27	0.54
12.5	1	12.5	—0.02	0.00	0.00
13.0	4	52.0	+0.48	0.23	0.92
13.5	6	81.0	+0.98	0.96	5.76
14.0	6	84.0	+1.48	2.19	13.14
14.5	3	43.5	+1.98	3.92	11.76
15.0	1	15.0	+2.48	6.15	6.15
15.5	1	15.5	+2.98	8.88	8.88
16.0	1	16.0	+3.48	12.11	12.11
16.5	0				
17.0	0				
17.5	0				
18.0	1	18.0	+5.48	30.03	30.03

$n = 39 \qquad \Sigma Vf = 488.5 \qquad \acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = 212.81$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{488.5}{39}$$

$$= 12.52 \pm 0.26$$

$$= \sqrt{\frac{212.81}{39}}$$

$$= 2.30$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{2.30}{\sqrt{39}}$$

$$= \pm 0.26$$

TABLE XII.—*Showing girth of trunk of Pico variety in Plantation No. 1 (centimeters)*

V	f	Vf	D	D^2	D^2f
180	1	180	—56.67	4,444.89	4,444.89
185	0				
190	0				
195	0				
200	1	200	—46.67	2,178.09	2,178.09
205	1	205	—41.67	1,736.39	1,736.39
210	1	210	—36.67	1,344.69	1,344.69
215	1	215	—31.67	1,002.99	1,002.99
220	0				
225	1	225	—21.67	469.59	469.59
230	0				
235	2	470	—11.67	136.19	272.38
240	1	240	— 6.67	44.49	44.49
245	1	245	— 1.67	2.79	2.79
250	0				
255	1	255	+ 8.33	69.39	69.39
260	3	780	+13.33	177.69	533.07
265	1	265	+18.33	335.99	335.99
270	0				
275	0				
280	0				
285	0				
290	0				
295	0				
300	0				
305	1	305	+58.33	3,402.39	3,402.39
310	0				
315	0				
320	1	320	+73.33	5,377.29	5,377.29
325	1	325	+78.33	6,135.59	6,135.59

$n = 18$ $\quad \Sigma Vf = 4440$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 27350.02$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{4440}{18}$$

$$= 246.67 \pm 6.57$$

$$= V\frac{27350.02}{18}$$

$$= 38.98$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{V n}$$

$$= \pm 0.6745 \frac{38.98}{V 18}$$

$$= \pm 6.57$$

TABLE XIII.—*Showing height of tree of Pico variety in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
9.0	1	9.0	—3.58	12.82	12.82
9.5	0				
10.0	2	20.0	—2.58	6.66	13.32
10.5	0				
11.0	1	11.0	—1.58	2.50	2.50
11.5	2	23.0	—1.08	1.17	2.34
12.0	1	12.0	—0.58	0.34	0.34
12.5	4	50.0	—0.08	0.01	0.04
13.0	0				
13.5	2	27.0	+0.92	0.85	1.70
14.0	1	14.0	+1.42	2.02	2.02
14.5	2	29.0	+1.92	3.69	7.38
15.0	0				
15.5	1	15.5	+2.92	8.53	8.53
16.0	1	16.0	+3.42	11.70	11.70

$n = 18$ $\quad \Sigma Vf = 226.5$ $\quad \acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}}$ $\quad \Sigma D^2 f = 62.69$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{226.5}{18}$$

$$= 12.58 \pm 0.31$$

$$\acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}}$$

$$= \sqrt{\frac{62.69}{18}}$$

$$= 1.86$$

$$P.E._m = \pm 0.6745 \sqrt{\frac{\acute{o}}{n}}$$

$$= \pm 0.6745 \sqrt{\frac{1.86}{18}}$$

$$= \pm 0.31$$

TABLE XIV.—*Showing spread of crown of Pico variety in Plantation No. 1 (meters)*

V	f	Vf	D	D^2	D^2f
9.0	1	9.0	—4.72	22.28	22.28
9.5	0				
10.0	0				
10.5	1	10.5	—3.32	10.37	10.37
11.0	0				
11.5	1	11.5	—2.22	4.93	4.93
12.0	0				
12.5	2	25.0	—1.22	1.49	2.98
13.0	1	13.0	—0.72	0.52	0.52
13.5	2	27.0	—0.22	0.05	0.10
14.0	2	28.0	+0.28	0.08	0.16
14.5	3	43.5	+0.78	0.61	1.83
15.0	0				
15.5	3	46.5	+1.78	3.17	9.51
16.0	0				
16.5	2	33.0	+2.78	7.73	15.46

$n = 18$ $\quad \Sigma Vf = 247.0$ $\quad ó = V\frac{\Sigma D^2f}{n}$ $\quad \Sigma D^2f = 68.14$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{247}{18}$$

$$= 13.72 \pm 0.32$$

$$= V\frac{68.14}{18}$$

$$= 1.94$$

$$P.E._m = \pm 0.6745 \frac{ó}{V\frac{}{n}}$$

$$= \pm 0.6745 \frac{1.94}{V\frac{}{18}}$$

$$= \pm 0.32$$

TABLE XV.—*Showing girth of trunks in Plantation No. 2 (centimeters)*

V	f	Vf	D	D^2	D^2f
70	1	70	— 93.79	8,796.56	8,796.56
75	0				
80	0				
85	1	85	— 78.79	6,207.86	6,207.86
90	0				
95	0				
100	0				
105	2	210	— 58.79	3,456.26	6,912.52
110	0				
115	1	115	— 48.79	2,380.46	2,380.46
120	0				
125	3	375	— 38.79	1,504.66	4,513.99
130	2	260	— 33.79	1,141.76	2,283.52
135	4	540	— 28.79	828.86	3,315.44
140	7	980	— 23.79	565.96	3,961.72
145	8	1,160	— 18.79	353.06	2,824.48
150	2	300	— 13.79	190.16	380.32
155	3	465	— 8.79	77.26	221.78
160	6	960	— 3.79	14.36	86.16
165	0				
170	7	1.190	+ 6.21	38.66	269.92
175	1	175	+ 11.21	125.66	125.66
180	1	180	+ 16.21	262.76	262.76
185	3	555	+ 21.21	449.86	1,349.58
190	1	190	+ 26.21	686.96	686.96
195	0				
200	2	400	+ 36.21	1,311.16	2,622.32
205	0				
210	2	420	+ 46.21	2,135.36	4,270.72
215	1	215	— 51.21	2,622.46	2,622.46
220	1	220	+ 56.21	3,159.56	3,159.56
225	0				
230	1	230	+ 66.21	4,383.76	4,383.76
235	2	470	+ 71.21	5,070.86	10,141.72
240	1	240	+ 76.21	5,807.96	5,807.96
245	0				
250	0				
255	1	255	+ 91.21	8,319.26	8,319.26
260	0				
265	0				
270	1	270	+106.21	11,280.56	11,280.56
275	0				
280	1	280	+116.21	13,504.76	13,504.76
285	0				

$n = 66 \qquad \Sigma Vf = 10810 \qquad \acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = 110692.77$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{10810}{66}$$

$$= 163.79 \pm 3.45$$

$$= \sqrt{\frac{110692.77}{66}}$$

$$= 40.90$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{40.90}{\sqrt{66}}$$

$$= \pm 3.45$$

TABLE XVI.—*Showing diameter of crown in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
4.5	2	9.0	—6.45	41.60	83.20
5.0	0				
5.5	0				
6.0	0				
6.5	1	6.5	—4.45	19.80	19.80
7.0	1	7.0	—3.95	15.60	15.60
7.5	3	22.5	—3.45	11.90	35.70
8.0	1	8.0	—2.95	8.70	8.70
8.5	6	51.0	—2.45	6.00	36.00
9.0	1	9.0	—1.95	3.80	3.80
9.5	5	47.5	—1.45	2.10	10.50
10.0	2	20.0	—0.95	0.90	1.80
10.5	5	52.5	—0.45	0.20	1.00
11.0	4	44.0	+0.05	0.00	0.00
11.5	11	126.5	+0.55	0.30	3.30
12.0	6	72.0	+1.05	1.10	6.60
12.5	4	50.0	+1.55	2.40	9.60
13.0	6	65.0	+2.05	4.20	21.00
13.5	0				
14.0	3	42.0	+3.05	9.30	27.90
14.5	2	29.0	+3.55	12.60	25.20
15.0	3	45.0	+4.05	16.40	49.20
15.5	0				
16.0	0				
16.5	1	16.5	+5.55	30.80	30.80

$n = 66$ $\quad \Sigma Vf = 723.0$ $\quad \delta = \sqrt{\frac{\Sigma D2f}{n}}$ $\quad \Sigma D^2f = 389.70$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{723.0}{66}$$

$$= 10.95 \pm 0.20$$

$$= \sqrt{\frac{389.70}{66}}$$

$$= 2.40$$

$$P.E._m = \pm 0.6745 \frac{\delta}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{2.40}{\sqrt{66}}$$

$$= \pm 0.20$$

TABLE XVII.—*Showing height of trees in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
6.0	1	6.0	—3.9	15.21	15.21
6.5	1	6.5	—3.4	11.56	11.56
7.0	0				
7.5	1	7.5	—2.4	5.76	5.76
8.0	3	24.0	—1.9	3.61	10.83
8.5	5	42.5	—1.4	1.96	9.80
9.0	9	81.0	—0.9	0.81	7.29
9.5	9	85.5	—0.4	0.16	1.44
10.0	10	100.0	+0.1	0.01	0.10
10.5	10	105.0	+0.6	0.36	3.60
11.0	7	77.0	+1.1	1.21	8.47
11.5	6	69.0	+1.6	2.56	15.36
12.0	1	12.0	+2.1	4.41	4.41
12.5	2	25.0	+2.6	6.76	13.52
13.0	0				
13.5	1	13.5	+3.6	12.96	12.96

$n = 66$ $\quad \Sigma Vf = 654.5$ $\quad \acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}}$ $\quad \Sigma D^2 f = 120.31$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{654.5}{66}$$

$$= 9.92 \pm 0.11$$

$$= \sqrt{\frac{120.31}{66}}$$

$$= 1.30$$

$$P.E._m = \pm 0.6745 \sqrt{\frac{\acute{o}}{n}}$$

$$= \pm 0.6745 \sqrt{\frac{1.30}{66}}$$

$$= \pm 0.11$$

TABLE XVIII.—*Showing distance of trees in the row in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
4.0	1	4.0	−3.4	11.56	11.56
4.5	3	13.5	−2.9	8.41	25.23
5.0	5	25.0	−2.4	5.76	28.80
5.5	7	38.5	−1.9	3.61	25.27
6.0	11	66.0	−1.4	1.96	21.56
6.5	10	65.0	−0.9	0.81	8.10
7.0	3	21.0	−0.4	0.16	0.48
7.5	5	37.5	+0.1	0.01	0.05
8.0	11	88.0	+0.6	0.36	3.96
8.5	1	8.5	+1.1	1.21	1.21
9.0	2	18.0	+1.6	2.56	5.12
9.5	3	28.5	+2.1	4.41	13.23
10.0	1	10.0	+2.6	6.76	6.76
10.5	1	10.5	+3.1	9.61	9.61
11.0	0				
11.5	1	11.5	+4.1	16.81	16.81
12.0	2	24.0	+4.6	21.16	42.32
12.5	3	37.5	+5.1	26.01	78.03
13.0	2	26.0	+5.6	31.36	62.72

$n = 72$ $\quad \Sigma Vf = 533.0$ $\quad ó = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 360.82$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{533.0}{72}$$

$$= 7.40 \pm 0.18$$

$$P.E._m = \pm 0.6745 \frac{ó}{V n}$$

$$= \pm 0.6745 \frac{2.23}{V 72}$$

$$= \pm 0.18$$

TABLE XIX.—*Showing girth of trunk of Carabao variety in Plantation No. 2 (centimeters)*

V	f	Vf	D	D^2	D^2f
70	1	70	− 91.71	8,410.72	8,410.72
75	0				
80	0				
85	0				
90	0				
95	0				
100	0				
105	1	105	− 56.71	3,216.02	3,216.02
110	0				
115	1	115	− 46.71	2,181.82	2,181.82
120	0				
125	0				
130	1	130	− 31.71	1,005.52	1,005.52
135	4	540	− 26.71	713.42	2,853.68
140	4	560	− 21.71	471.32	1,885.28
145	3	435	− 16.71	279.22	837.66
150	1	150	− 11.71	137.12	137.12
155	2	310	− 6.71	45.02	90.04
160	4	640	− 1.71	2.92	11.68
165	0				
170	4	680	+ 8.29	68.72	274.88
175	0				
180	0				
185	1	185	+ 23.29	542.42	542.42
190	1	190	+ 28.29	800.32	800.32
195	0				
200	2	400	+ 38.29	1,466.12	2,932.24
205	0				
210	1	210	+ 48.29	2,331.92	2,331.92
215	1	215	+ 53.29	2,839.82	2,839.82
220	1	220	+ 58.29	3,397.72	3,397.72
225	0				
230	0				
235	1	235	+ 73.29	5,371.42	5,371.42
240	0				
245	0				
250	0				
255	0				
260	0				
265	0				
270	1	270	+108.29	11,726.72	11,726.72

$n = 35$ $\quad \Sigma Vf = 5660$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 50847.00$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{5660}{35}$$

$$= 161.71 \pm 4.25$$

$$= V\frac{50847.00}{35}$$

$$= 38.10$$

$$P.E._m = \pm 0.6745\frac{\acute{o}}{V n}$$

$$= \pm 0.6745\frac{38.10}{V 35}$$

$$= \pm 4.25$$

TABLE XX.—*Showing height of tree of Carabao variety in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
6.5	1	6.5	—3.48	12.11	12.11
7.0	0				
7.5	0				
8.0	1	8.0	—1.98	3.92	3.92
8.5	2	17.0	—1.48	2.19	4.38
9.0	5	45.0	—0.98	0.96	4.80
9.5	6	57.0	—0.48	0.23	1.38
10.0	6	60.0	—0.02	0.00	0.00
10.5	4	42.0	+0.52	0.27	1.08
11.0	6	66.0	+1.02	1.04	6.24
11.5	3	34.5	+1.52	2.31	6.93
12.0	0				
12.5	0				
13.0	0				
13.5	1	13.5	+3.52	12.39	12.39

$n = 35$ $\quad \Sigma Vf = 349.5$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 53.23$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{349.5}{35}$$

$$= 9.98 \pm 0.14$$

$$= V\frac{53.23}{35}$$

$$= 1.23$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{V n}$$

$$= \pm 0.6745 \frac{1.23}{V 35}$$

$$= \pm 0.14$$

TABLE XXI.—*Showing spread of crown of Carabao variety in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
4.5	1	4.5	—6.97	48.58	48.58
5.0	0				
5.5	0				
6.0	0				
6.5	1	6.5	—4.97	24.70	24.70
7.0	0				
7.5	0				
8.0	1	8.0	—3.47	12.04	12.04
8.5	0				
9.0	0				
9.5	2	19.0	—1.97	3.88	7.76
10.0	1	10.0	—1.47	2.16	2.16
10.5	5	52.5	—0.97	0.94	4.70
11.0	1	11.0	—0.47	0.22	0.22
11.5	9	103.5	+0.03	0.00	0.00
12.0	2	24.0	+0.53	0.28	0.56
12.5	2	25.0	+1.03	1.06	2.12
13.0	5	65.0	+1.53	2.34	11.70
13.5	0				
14.0	2	28.0	+2.53	6.40	12.80
14.5	1	14.5	+3.03	9.18	9.18
15.0	2	30.0	+3.53	12.46	24.92

$n = 35$ $\quad \Sigma Vf = 401.5$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 161.44$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{401.50}{35}$$

$$= 11.47 \pm 0.24$$

$$\acute{o} = V\frac{\Sigma D^2 f}{n}$$

$$= V\frac{161.44}{35}$$

$$= 2.14$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{V n}$$

$$= \pm 0.6745 \frac{2.14}{V 35}$$

$$= \pm 0.24$$

TABLE XXII.—*Showing girth of trunk of Pico variety in Plantation No. 2 (centimeters)*

V	f	Vf	D	D^2	D^2f
85	1	85	— 77.74	6,043.51	6,043.51
90	0				
95	0				
100	0				
105	1	105	— 57.74	3,333.91	3,333.91
110	0				
115	0				
120	0				
125	3	375	— 37.74	1,424.31	4,272.93
130	1	130	— 32.74	1,071.91	1,071.91
135	1	135	— 27.74	769.51	769.51
140	3	420	— 22.14	517.11	1,551.33
145	5	725	— 17.74	314.71	1,573.55
150	0				
155	0				
160	4	640	— 2.74	7.51	30.04
165	0				
170	3	510	+ 7.26	52.71	158.13
175	1	175	+ 12.26	150.31	150.31
180	1	180	+ 17.26	297.91	297.91
185	2	370	+ 22.26	495.51	991.02
190	0				
195	0				
200	0				
205	0				
210	1	210	+ 47.26	2,233.51	2,233.51
215	0				
220	0				
225	0				
230	1	230	+ 67.26	4,523.91	4,523.91
235	1	235	+ 72.26	5,221.51	5,221.51
240	1	240	+ 77.26	5,969.11	5,969.11
245	0				
250	0				
255	0				
260	0				
265	9				
270	0				
275	0				
280	1	280	+117.26	13,749.91	13,749.91

$n = 31 \qquad \Sigma Vf = 5045$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{5045}{31}$$

$$= 162.74 \pm 5.52$$

$$\acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = V51942.01$$

$$= \sqrt{\frac{51942.01}{31}}$$

$$= 40.93$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{40.93}{\sqrt{31}}$$

$$= \pm 5.52$$

TABLE XXIII.—*Showing height of tree of Pico variety in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
6.0	1	6.0	—3.75	14.06	14.06
6.5	0				
7.0	0				
7.5	1	7.5	—2.25	5.06	5.06
8.0	2	16.0	—1.75	3.06	6.12
8.5	3	25.5	—1.25	1.56	4.68
9.0	5	45.0	—0.75	0.56	2.80
9.5	3	28.5	—0.25	0.06	0.18
10.0	4	40.0	+0.25	0.06	0.24
10.5	6	63.0	+0.75	0.56	3.36
11.0	1	11.0	+1.25	1.56	1.56
11.5	2	23.0	+1.75	3.06	6.12
12.0	1	12.0	+2.25	5.06	5.06
12.5	2	25.0	+2.75	7.56	15.12

$n = 31 \quad \Sigma Vf = 302.5$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{302.5}{31}$$

$$= 9.75 \pm 0.18$$

$$\acute{o} = \sqrt{\frac{\Sigma D^2 f}{n}} \qquad \Sigma D^2 f = 64.36$$

$$= \sqrt{\frac{64.36}{31}}$$

$$= 1.43$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{1.43}{\sqrt{31}}$$

$$= \pm 0.18$$

TABLE XXIV.—*Showing spread of crown of Pico variety in Plantation No. 2 (meters)*

V	f	Vf	D	D^2	D^2f
4.5	1	4.5	—5.80	33.64	33.64
5.0	0				
5.5	0				
6.0	0				
6.5	0				
7.0	1	7.0	—3.30	10.89	10.89
7.5	3	22.5	—2.80	7.84	23.52
8.0	0				
8.5	5	42.5	—1.80	3.24	16.20
9.0	1	9.0	—1.30	1.69	1.69
9.5	4	38.0	—0.80	0.64	2.56
10.0	1	10.0	—0.30	0.09	0.09
11.0	3	33.0	—0.70	0.49	1.47
11.5	2	23.0	+1.20	1.44	2.88
12.0	4	48.0	+1.70	2.89	11.56
12.5	2	25.0	+2.20	4.84	9.68
13.0	0				
13.5	1	13.5	+3.20	10.24	10.24
14.0	1	14.0	+3.70	13.69	13.69
14.5	1	14.5	+4.20	17.64	17.64
15.0	1	15.0	+4.70	22.09	22.09

$n = 31$ $\quad \Sigma Vf = 319.5$

$$M = \frac{\Sigma Vf}{n} = \frac{319.5}{31} = 10.30 \pm 0.29$$

$$\acute{o} = V\frac{\Sigma D^2 f}{n} = V\frac{177.84}{31} = 2.39 \qquad \Sigma D^2 f = 177.84$$

$$P.E._m = \pm 0.6745 V\frac{\acute{o}}{n} = \pm 0.6745 V\frac{2.39}{31} = \pm 0.29$$

TABLE XXV.—*Showing weight of regular-season fruits of Carabao variety in Plantation No. 2 (grams)*

Sample No.	Rank	V	D	D^2
O–A–1	1	260	— 31.7	1,004.89
O–A–4	2	190	—101.7	10,342.89
O–A–7	3	223	— 68.7	4,719.69
O–A–11	4	225	— 66.7	4,448.89
O–A–14	5	210	— 81.7	6,674.89
I–A–8	6	305	+ 13.3	176.89
I–A–11	7	305	+ 13.3	176.89
I–A–14	8	290	— 1.7	2.89
I–A–15	9	300	+ 8.3	68.89
I–A–16	10	260	— 31.7	1,004.89
I–A–18	11	260	— 31.7	1,004.89
I–A–21	12	240	— 51.7	2,672.89
I–A'–6	13	290	— 1.7	2.89
I–A'–9	14	340	+ 48.3	2,332.89
I–A'–10	15	315	+ 23.3	542.89
I–A'–12	16	290	— 1.7	2.89
I–A'–13	17	290	— 1.7	2.89
I–A'–20	18	315	+ 23.3	542.89
I–A'–23	19	400	+108.3	11,728.89
II–A–4	20	340	+ 48.3	2,332.89
II–A–6	21	290	— 1.7	2.89
II–A–7	22	505	+213.3	45,496.89
II–A–8	23	315	+ 23.3	542.89
II–A–9	24	280	— 11.7	136.89
II–A–12	25	270	— 21.7	470.89
II–A–15	26	300	+ 8.3	68.89
II–A–16	27	270	— 21.7	470.89
II–A–19	28	285	— 6.7	44.89
II–A–21	29	295	+ 3.5	10.89

$n = 29$ $\quad \Sigma V = 8458$ $\quad \acute{o} = V\frac{\Sigma D^2}{n}$ $\quad \Sigma D^2 f = 97034.61$

$$M = \frac{\Sigma V}{n}$$

$$= \frac{8458}{29}$$

$$= 291.66 \pm 7.49$$

$$= V\frac{97034.61}{29}$$

$$= 57.84$$

$$P.E._m = \pm 0.6745\frac{\acute{o}}{V n}$$

$$= \pm 0.6745\frac{57.84}{V 29}$$

$$= \pm 7.49$$

TABLE XXVI.—*Showing weight of regular-season fruits, Pico variety, in Plantation No. 2 (grams)*

Sample No.	Rank	V	D	D^2
OA–12	1	190	—17.37	301.71
OA–13	2	180	—27.37	749.11
IA–10	3	220	+12.63	159.51
IA–13	4	200	— 7.37	54.41
IA–20	5	210	+ 2.63	6.91
IA–27	6	183	—24.37	593.89
IA'–11	7	195	—12.37	153.01
IA'–16	8	215	+ 7.63	58.21
IA'–17	9	215	+ 7.63	58.21
IA'–19	10	215	+ 7.63	58.21
IIA–1	11	265	+57.63	3,321.21
IIA–10	12	170	—37.37	1,396.51
IIA–14	13	190	—17.37	301.71
IIA–17	14	210	+ 2.63	6.91
IIA–18	15	220	+12.63	159.51
IIA–20	16	240	+32.63	1,066.71

$n = 16$ $\quad \Sigma V = 3318$ $\quad \acute{o} = \sqrt{\frac{\Sigma D^2}{n}}$ $\quad \Sigma D^2 = 8443.75$

$$M = \frac{\Sigma V}{n}$$

$$= \frac{3318}{16}$$

$$= 207.37 \pm 3.87$$

$$P.E._m = \pm 0.6745 \frac{\acute{o}}{\sqrt{n}}$$

$$= \pm 0.6745 \frac{22.97}{\sqrt{16}}$$

$$= \pm 3.87$$

TABLE XXVII.—*Showing consolidated yields of Carabao fruits, 1927–1928 smudge (in baskets)*

V	f	Vf	D	D^2	D^2f
¼	1	0.25	— 3.68	13.54	13.54
½	1	.50	— 3.43	11.76	11.76
1	23	23.00	— 2.93	8.58	197.34
2	18	36.00	— 1.93	3.72	66.96
2½	1	2.50	— 1.43	2.04	2.04
3	3	9.00	— 0.93	0.86	2.58
4	7	28.00	+ 0.07	0.00	0.00
5	7	35.00	+ 1.07	1.14	7.98
7	1	7.00	+ 3.07	9.42	9.42
8	2	16.00	+ 4.07	16.56	33.12
10	1	10.00	+ 6.07	36.84	36.84
12	1	12.00	+ 8.07	65.12	65.12
13	1	13.00	+ 9.07	82.26	82.26
14	2	28.00	+10.07	101.40	202.80
15	1	15.00	+11.07	122.54	122.54
21	1	21.00	+17.07	291.38	291.38
27	1	27.00	+23.07	532.22	532.22

$n = 72$ $\quad \Sigma Vf = 283.25$ $\quad ó = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 1668.48$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{283.25}{72}$$

$$= 3.93 \pm 0.38$$

$$= V\frac{1668.48}{72}$$

$$= 4.81$$

$$P.E._m = \pm 0.6745 \frac{ó}{V\overline{n}}$$

$$= \pm 0.6745 \frac{4.81}{V\overline{2}}$$

$$= \pm 0.38$$

NOTE.—An empty basket (kaing) with sufficient bedding of banana leaves inside weighs 3.05 kilos.

TABLE XXVIII.—*Showing consolidated yields of Pico fruits, 1927–1928 smudge (in baskets)*

V	f	Vf	D	D^2	D^2f
½	16	8.0	— 3.05	9.30	148.80
1	19	19.0	— 2.55	6.50	123.50
1½	1	1.5	— 2.05	4.20	4.20
2	11	22.0	— 1.55	2.40	26.40
3	6	18.0	— 0.55	0.30	1.80
4	9	36.0	+ 0.45	0.20	1.80
5	5	25.0	+ 1.45	2.10	10.50
6	3	18.0	+ 2.45	6.00	18.00
7	5	35.0	+ 3.45	11.90	59.50
8	1	8.0	+ 4.45	19.80	19.80
9	2	18.0	+ 5.45	29.70	59.40
10	1	10.0	+ 6.45	41.60	41.60
11	0				
12	0				
13	2	26.0	+ 9.45	89.30	178.60
14	1	14.0	+10.45	109.20	109.20
15	0				
16	0				
17	1	17.0	+13.45	180.90	180.90
18	0				
19	0				
20	0				
21	0				
22	0				
23	1	23.0	+19.45	378.30	378.30

$n = 84$ $\quad \Sigma Vf = 298.5$ $\quad \acute{o} = V\frac{\Sigma D^2 f}{n}$ $\quad \Sigma D^2 f = 1362.30$

$$M = \frac{\Sigma Vf}{n}$$

$$= \frac{298.5}{84}$$

$$= 3.55 \pm 0.30$$

$$\text{P.E.}_m = \pm 0.6745 \frac{\acute{o}}{V n}$$

$$= \pm 0.6745 \frac{4.02}{V 84}$$

$$= \pm 0.30$$

TABLE XXIX.—*Showing comparative weight of fruits due to smudging in grams (1927–1928)*

Carabao			Pico		
Average weight per fruit	D	D^2	Weight per fruit	D	D^2
275.0	−31.0	961.00	250.0	+17.5	306.25
375.0	+69.0	4,761.00	225.0	— 7.5	56.25
312.5	+ 6.5	42.25	250.0	+17.5	306.25
300.0	— 6.0	36.00	275.0	+42.5	1,806.25
250.0	−56.0	3,136.00	212.5	−20.0	400.00
312.5	+ 6.5	42.25	212.5	−20.0	400.00
322.5	+16.5	272.25	225.0	— 7.5	56.25
312.5	+ 6.5	42.25	225.0	— 7.5	56.25
300.0	— 6.0	56.00	225.0	— 7.5	56.25
300.0	— 6.0	36.00	225.0	— 7.5	56.25

$\Sigma 3060.0 \qquad \Sigma 9365.00 \qquad \Sigma 2325.0 \qquad \Sigma 3500.00$

Mean $= 306.0 \pm 6.87$ Mean $= 232.5 \pm 4.20$

$$P.E._m = \pm 0.6745 \frac{\Sigma D^2}{Vn\,(n\text{-}l)} \qquad P.E._m = \pm 0.6745 \frac{\Sigma D^2}{Vn\,(n\text{-}l)}$$

$$= \pm 0.6745 \frac{9365.00}{V10(10\text{-}1)} \qquad = \pm 0.6745 \frac{3500}{V10(10\text{-}1)}$$

$= \pm 6.87$ $= \pm 4.20$

SUMMARY TABLE I

Details	Plantation No. 1	Plantation No. 2	Difference in favor of plantation—	
			No. 1	No. 2
Girth of trunk.....in cms..	255.08±6.55	163.79±3.45	91.29±7.40	
Height of tree.....in meters..	11.90±0.16	9.92±0.11	1.98±0.19	
Diameters of crown.....in meters..	13.00±0.18	10.95±0.20	2.05±0.27	
Distance in the row.....in meters..	13.60±0.16	7.40±0.18	6.20±0.24	
Distance of rows.....in meters..	13.47±0.43	.....	.....	

SUMMARY TABLE II

Details	Plantation No. 1		Difference in favor of—	
	Carabao	Pico	Carabao	Pico
Girth of trunk.....in cms..	240.64±7.20	246.67±6.57	.....	6.03±9.74
Height of tree.....in meters..	11.45±0.20	12.58±0.31	.....	1.13±0.37
Spread of crown.....in meters..	12.52±0.26	13.72±0.32	.....	1.20±0.41

SUMMARY TABLE III

Details	Plantation No. 2		Difference in favor of—	
	Carabao	Pico	Carabao	Pico
Girth of trunk.....in cms..	161.71±4.25	162.74±5.52	.....	1.03±6.96
Height of tree.....in meters..	9.98±0.14	9.75±0.18	0.230±.22	.....
Spread of crown.....in meters..	11.47±0.24	10.30±0.29	1.170±.26	.....
Average weight of fruit..in grams..	291.66±7.49	207.37±3.87	84.298±.43	.....

DISCUSSION OF RESULTS

Summarizing Tables IV to VIII and XV to XVIII, the girth of trunk in Plantation No. 1 is 91.29 ± 7.40 centimeters more than the girth of trunk in Plantation No. 2; 1.98 ± 0.19 meters in height of trees in favor of Plantation No. 1; 2.05 ± 0.27 meters spread of crown in favor of Plantation No. 1; and the distance of planting in Plantation No. 1 is 6.20 ± 0.24 meters wider than in Plantation No. 2.

In Table II, summarizing Tables IX to XIV, there is no significant difference in the size of girth, height of trees and spread of crown of the carabao and pico varieties of the same age in Plantation No. 1.

In summary Table III, summarizing Tables XIX, XX, XXI, XXII, XXIII, and XXIV, there is no significant difference in the size of girth of trunk and height of trees of the two varieties in Plantation No. 2 at higher altitudes, except for the carabao variety, is 1.17 ± 0.36 meters more in the size of crown and the individual average weight of fruit is heavier by 84.29 ± 8.43 grams than pico, as shown in Tables XXV and XXVI, which explains partly why the fruit of the former variety, carabao, is not able to resist the effect of high winds and the rainy season.

In the year 1925, a study of crop production was made in Plantation No. 2 on 64 trees, 35 carabaos and 29 picos. Twenty-nine carabao trees or 82.9 per cent fruited with an average of 109.1 kilos per tree, and the 16 Pico trees or 55.2 per cent fruited with an average yield of 121.5 kilos.

In the year 1926, the same study was extended to 50 trees of carabao variety in Plantation No. 1, 14 trees fruited amounting to 3,986 fruits weighing 1,171 kilos or an average yield of 284.7 fruits per tree, weighing 83.6 kilos while the pico variety in the same plantation, eight out of the 27 trees fruited, yielding 8,061 fruits, weighing 1,811 kilos or an average of 1,007.5 fruits weighing 226.3 kilos per tree. In Plantation No. 2, of the total number of 49 trees of carabao, three trees yielded 810 fruits weighing 76 kilos and of the 39 pico trees, 29 trees fruited with a total production of 24,045 fruits, with a total weight of 5,019 kilos or 829 fruits weighing 173 kilos to the tree. Due to weakness of the stem of carabao fruits to stand the effect of high winds and the rainy season, the yield is less than that of the pico variety. The advantage of the pico is the ability of its fruit to withstand unfavorable weather. But even so, the carabao is preferred for its size and quality.

In Table XXVII the average production of the 72 trees of the carabao variety as smudged is 3.93 ± 0.38 *kaings* and that of the 84 trees of the pico variety as smudged as shown in Table XXVIII is 3.55 ± 0.30 *kaings* which means there is no significant difference in the yield of the two means in terms of baskets as the unit of measure.

It may be added that the average gross weight of one *kaing* of the carabao variety is 40.48 kilos containing 124 fruits and that of the Pico is 44.48 kilos containing 180 fruits.

In Table XXIX the average weight of ten fruits each of carabao and pico is 300.0 ± 6.87 and 232.5 ± 4.20 grams, respectively, produced due to smudging, or a difference of 73.5 ± 8.05 grams in favor of the former variety.

PESTS AND DISEASES

The most common insects found attacking clusters of flowers of mango are the mango hoppers and mango tip borer (*Chlumetra transeversa*).

The mango hoppers (*Idiocerus* spp.) suck the juice of the flowers thereby causing the failure of the development of fruits.

The tip borer is a destructive pest of the mango tree in flowers. The insect attacks immediately after the flower clusters are formed and is easily recognized by the blackening of the tips. The larva may be seen crawling outside but generally bores into the stalks, eating up the core. The stalks weaken and hang or fall to the ground.

Another thing that damages flowers at the pollinating stage is rainfall. Two or three days after, the effect of rain is very visible, for the flowers wilt, dry and fall off.

The effects of pest and disease attacks may be minimized by the use of insecticides, fungicides and other sanitary measures but rainfall is beyond the control of human power.

SUMMARY AND CONCLUSION

1. Mango trees develop a bigger girth of trunk, higher stature and bigger size of crown at a lower elevation with spacing of 13.60 ± 0.16 meters in the rows than mango trees grown at higher elevation with spacing of 7.40 ± 0.18 meters in the row under Muntinlupa conditions.

2. The carabao and pico varieties of mango, under lowland conditions, differ in height, the pico being the taller.

3. In higher altitudes the carabao variety develops a bigger crown than pico.

4. A significant difference in weight of fruit in favor of the carabao mango over the pico variety is found both in the regular season and off-season.

5. The stems of fruits of the pico variety resist the rainy season and high winds better than the stems of fruits of the Carabao.

6. A mango tree 60 meters away from a bonfire is caused to produce fruits by stray smoke, which seems to show that it is not the heating of the tree and ground as well under which the roots are but the stimulating effect of the smoke that forces a mango tree of bearing age with mature twigs and leaves to produce fruits out of season.

RECOMMENDATIONS

1. Profitable smudging may be done in the middle part of December, before Christmas or in the earliest part of January when insect pests are not numerous.

2. In the majority of cases, according to observations, smudging started during the full moon, succeeded in the formation of fruits, thereby forestalling probable rainfalls during the new moon at which time the flowers are in pollination.

3. A second smudging is advisable, especially when the flowers produced due to the first smudging have been damaged by rain. This will induce the tree to produce a second set of flowers.

REFERENCES

1. DAVENPORT, E., and RIETZ, H. L.: Principles of Breeding. Ginn & Co., Boston. 1907.
2. BATCHELOR, L. D., and REED, H. S.: Relation of the Variability of Yields of Fruit Trees to the Accuracy of Field Trials. Journal of Agricultural Research. Vol. XII, No. 5, February 4, 1918.

YIELDS OF PARA RUBBER IN BATAAN

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The discussion about the soil and climatic conditions, and the materials and methods used for this experiment were purposely omitted in the presentation of this article inasmuch as the yield data hereunder reported is nothing but a continuation of the result of tapping the Para rubber trees in Abukay, Bataan, which was published in the Philippine Agricultural Review, Vol. XX, Fourth Quarter, 1927, No. 4, pp. 461–468; and these were already taken up in the said article. Table I below shows the individual tree yield of latex in liters and its equivalent of dry rubber in kilos of both smoked sheets, cup washings, and tree scraps, from April 12, 1926, to November 15, 1929, while Table II gives the monthly yield of the Para rubber trees.

In tapping the Para rubber trees the rubber contents obtained were 28.60 per cent from April 12, 1926, to May 15, 1927; 29.73 per cent from June 15, 1927, to July 17, 1928; and 30.73 per cent from October 15, 1928, to November 15, 1929. Calculating from these rubber contents, the yields ranged from 0.48 to 37.69 grams of dry rubber a tree per tapping day, while the ten highest yielding trees gave an average yield of 26.853 grams of dry rubber per tapping day. Computing with the total as a basis, the average yield per tree was 11.54 grams of dry rubber per tapping day, or 2.1 kilos a tree per year if the trees were tapped alternate days or months, or 182 tapping days in a year. Taking 6.5 meters apart as the average distance of planting the Para rubber tree, or 232 trees to the hectare, the yield would be about 487 kilos of dry rubber a year per hectare. In the Middle East the yield varies from 234 to 633 kilos to the hectare. Comparatively speaking, therefore, the yield obtained in Abukay, Bataan, is not behind that of the Middle East in spite of the frequent occurrences of typhoons and the distinct dry season in the place where the tapping test has been undertaken.

The trees in Abukay were about 17 to 18 years old in 1929, when the yield was about 2.564 kilos of dry rubber a tree, or

equivalent to about 467 kilos per hectare. In Ceylon 18-year-old trees gave an average yield of 334 kilos; in Indo-China, 474 kilos; and in Java, 372 kilos of dry rubber to the hectare.

During the course of the experiment, from May 12, 1926, to November 15, 1929, with the exception of October and November, 1927, and August to September, 1928, when no tapping were done, higher yields were obtained during the months of October, November, December, and January. There were lower yields during the months of February, March, and April, while during the months of May, June, July, August, and September fairly good yields were obtained. In Java the best production is attained during the months of December, April, and March, and lower yields occur in July and August, while during the month of June a fairly good yield is obtained. In Malaya the best yield is obtained from October to February. The crop gets smaller until from March the fresh leaves come out, which is in June. The best yielding month is December, and April is the poorest. The normal yield occurs in May. As to yield the Para rubber trees in Bataan behave like those of Malaya and differently from those of Java.

TABLE II.—*Showing the monthly yields of the Para rubber trees in Abukay, Bataan*

Month	Number of trees tapped	Number of—		Yield of—				Total		Remarks
		Tapping days	Days actually tapped	Latex in kilos	Dry rubber in kilos from—			Per month	Per tapping day	
					Latex	Washing	Scrap			
April 12, 1926–May 11, 1926	88	30	30	57.714	19.650	2.323	2.663	24.636	0.821	
June 15, 1926–July 14, 1926	87	30	28	74.193	18.620	0.819	1.592	21.031	0.751	No tapping for 2 days due to rains.
August 15, 1926–September 14, 1926	82	31	17	50.670	11 615	0.635	0.708	12.958	0.762	No tapping for 14 days due to rains.
October 16, 1926–November 15, 1926	82	31	28	105 765	22.217	1.090	1.182	24.489	0.875	No tapping for 3 days due to rains.
December 15, 1926–January 15, 1927	80	32	27	95 992	24.485	0.920	1.122	26.527	0.983	No tapping for 5 days due to rains and holidays.
February 16, 1927–March 15, 1927	80	29	28	68.797	17.866	0.819	1.141	19.826	0.708	
April 15, 1927–May 15, 1927	81	31	21	37.601	10.754	0.718	1.224	12.696	0.605	No tapping for 10 days due to lack of acid.
June 15, 1927–July 14, 1927	76	30	20	58.421	16 457	0.751	0.992	18.200	0.910	No tapping for 10 days due to rains and the tapper was sick.
August 17, 1927–September 15, 1927	78	28	17	63.054	16.641	0.723	1.077	18.441	1.085	No tapping for 10 days due to rains and on September 9th the latex from 36 trees was not collected.
December 15, 1927–January 15, 1928	77	32	32	153.911	41.677	1.496	1.349	44.522	1.391	
February 16, 1928–March 15, 1928	78	29	28	67.861	15.666	0.539	2.336	18.541	0.662	No tapping for one day due to rains.
April 15, 1928–May 15, 1928	78	31	31	97.118	26.422	1.029	2.350	29.801	0.961	
June 20, 1928–July 19, 1928	77	32	7	21.420	6.329	0.162	0.471	6.962	0.995	No tapping for 25 days due to rains and the tapper was sick.
October 15, 1928–November 13, 1928	77	30	28	144.604	37.521	1.021	3.158	41.700	1.489	No tapping for 2 days due to rains.
December 15, 1928–January 15, 1929	77	32	25	110.010	27.046	0.646	2.934	30.626	1.225	No tapping for 7 days due to rains and the tapper was sick.
February 15, 1929–March 15, 1929	77	29	29	68.645	18.442	0.805	2.728	21.975	0.758	
April 15, 1929–May 15, 1929	77	31	31	106.044	32.702	1.182	2.767	36.651	1.182	
June 18, 1929–July 15, 1929	77	28	24	77.197	21.767	0.734	1.701	24.202	1.008	No tapping for 4 days due to rains.
August 16, 1929–September 15, 1929	77	31	17	44.771	13.067	0.558	1.446	15.071	0.887	No tapping for 17 days due to rains.
October 16, 1929–November 15, 1929	76	31	29	88.922	23.468	0.851	2.438	26.757	0.923	No tapping for 2 days due to rains.
Total	1,582	608	497	1,592.710	422 412	17.821	35.379	475.617	18.981	No tapping for 112 days.
Average	79.1	30.4	24.85	79.636	21.121	0.891	1.769	23.781	0.949	

TABLE I.—*Showing the individual tree yield of Para rubber in Abucay, Bataan*

Tree No.	Girth 3 feet from the base		April 12, 1926–May 15, 1927				June 15, 1927–July 17, 1928				October 15, 1928–November 15, 1929	
			Tapping days				Tapping days				Tapping days	
	April 1926	July 1929	Yielding	Non yielding	Latex	Dry rubber	Yielding	Non yielding	Latex	Dry rubber	Yielding	Non yielding
	Inches	*Inches*			*Liters*	*Kilos*			*Liters*	*Kilos*		
1	22.5	37.0	171	.....	5.580	1.596	135	.....	5.436	1.616	183	.....
2	33.4	41.3	168	10	10.089	2,885	128	7	3.132	0.931	183	.....
3	29.6	43.3	178	.....	13.750	3.932	135	.....	10.715	3.186	183	.....
4	25.2	.....	166	12	3.538	1.012	.....	.....	.....	.....	.....	.....
5	16.3	27.2	174	4	2.292	0.656	134	1	3.178	0.945	180	3
6	26.8	39.4	177	1	6.387	1.827	135	.....	5.954	1.770	183	.....
7	29.8	32.3	176	2	3.485	0.997	134	1	4.319	1.284	182	1
8	32.0	50.7	178	.....	8.570	2.451	131	4	3.429	1.020	183	.....
9	34.2	45.3	177	1	3.746	1.071	135	.....	4.716	1.402	183	.....
10	43.8	50.0	176	2	8.596	2.458	135	.....	7.866	2.339	181	2
11	21.5	30.7	164	14	1.538	0.440	134	1	1.799	0.535	181	2
12	37.6	51.2	178	.....	9.562	2.734	135	.....	9.041	2.688	181	2
13	32.7	53.9	175	3	5.285	1.511	134	1	8.697	2.586	181	2
14	20.2	30.3	147	31	2.754	0.788	134	1	4.051	1.204	163	20
15	21.1	31.5	175	3	3.841	1.098	135	.....	5.160	1.534	183	.....
16	37.0	52.4	176	2	19.378	5.541	135	.....	15.479	4.602	183	.....
17	33.0	49.2	177	1	8.778	2.510	135	.....	6.532	1.942	183	.....
18	36.1	44.1	177	1	8.149	2.044	135	.....	7.698	2.289	181	2
19	35.8	50.1	178	1	15.296	4.374	135	.....	12.302	3.657	183	.....
20	32.8	45.7	178	1	9.807	2.505	135	.....	7.340	2.182	182	1
21	26.6	.....	179	.....	4.590	1.313	.....	.....	.....	.....	.....	.....
22	25.0	37.8	178	1	3.442	0.984	127	8	3.885	1.155	182	1
23	27.0	37.8	179	.....	6.508	1.861	135	.....	4.678	1.391	183	.....
24	34.0	45.3	179	.....	13.500	3.861	135	.....	10.253	3.048	183	.....
25	25.9	41.3	164	15	2.650	0.758	113	22	2.987	0.788	162	21
26	27.6	40.2	176	3	2.904	0.831	135	.....	3.760	1.118	182	1
27	23.7	28.5	176	3	6.643	1.900	135	.....	6.099	1.813	178	5
28	24.9	27.2	178	1	7.696	2.201	133	2	5.240	1.558	177	6
29	27.9	32.7	173	6	2.061	0.589	134	1	2.851	0.848	180	3
30	40.1	.....	179	.....	11.420	3.266	.....	.....	.....	.....	.....	.....

31	32.1	42.9	179	.....	11.013	3.149	134	1	6.470	1.924	179	4
32	35.8	41.7	179	.....	16.981	4.856	135	.....	12.029	3.576	182	1
33	21.6	27.6	179	.....	5.012	1.433	101	2	1.986	0.591	182	1
34	19.9	30.3	179	.....	1.844	0.527	132	3	2.185	0.650	170	13
35	25.8	38.2	179	.....	9.270	2.651	135	.....	6.289	1.870	177	6
36	18.9	29.9	179	.....	6.972	1.994	135	.....	5.434	1.616	182	1
37	21.2	35.0	177	2	5.314	1.520	136	.....	5.805	1.726	183	.....
38	26.5	40.9	178	1	10.178	2.911	135	1	11.220	3.336	183	.....
39	16.9	29.9	179	.....	4.457	1.275	136	.....	4.385	1.304	172	11
40	24.2	33.1	179	.....	3.248	0.929	136	.....	3.396	1.010	183	.....
41	17.2	24.4	179	.....	2.910	0.832	136	.....	3.354	0.997	183	.....
42	31.0	50.8	153	26	14.163	4.050	136	.....	11.183	3.325	183	.....
43	22.5	31.9	156	21	1.868	0.534	126	10	1.764	0.525	175	8
44	41.8	60.2	179	.....	15.282	4.370	136	.....	14.141	4.204	183	.....
45	19.0	36.2	178	1	2.414	0.690	129	7	3.465	1.030	145	38
46	20.7	28.7	164	15	7.903	2.260	116	.....	6.081	1.808	137	Rested
47	32 7	48.4	179	.....	13.099	3.746	136	.....	13.707	4.075	183	.....
48	16.4	29.1	176	3	4.383	1.253	135	1	5.925	1.762	180	3
49	20.5	35.8	178	.....	3.945	1.128	136	.....	4.553	1.354	182	1
50	24.5	34.6	178	.....	5.624	1.608	136	.....	5.485	1.631	181	2
51	29.2	48.4	152	26	3.113	0.890	136	.....	3.776	1.123	183	.....
52	27.0	39.4	170	8	6.766	1.935	134	2	7.983	2.373	176	7
53	23.8	37.8	178	.....	9.043	2.596	136	.....	11.536	3.430	181	2
54	26.0	34.6	172	6	4.103	1.173	136	.....	5.198	1.545	164	19
55	28.5	45.3	178	.....	5.335	1.526	136	.....	6.032	1.793	183	.....
56	22.4	39.8	171	7	1.949	0.557	131	5	2.928	0.868	176	7
57	24.1	.....	169	9	2.899	0.829	127	2	3.442	1.023	.....	Rested
58	19.5	29.1	163	15	1.424	0.407	133	3	3.908	1.162	183	.....
59	35.4	57.9	178	.....	13.120	3.752	136	.....	11.250	3.345	183	.....
60	19.4	28.5	176	2	4.536	1.297	134	2	7.428	2.208	182	1
61	25.2	39.4	177	1	3.014	0.862	136	.....	3.041	0.904	181	2
62	21.4	39.8	177	1	5.317	1.521	134	2	7.252	2.156	183	.....
63	16.3	24.0	176	2	2.323	0.664	136	.....	2.905	0.864	183	.....
64	23.7	25.2	174	4	4.784	1.368	135	1	4.848	1.441	175	8
65	18.4	37.4	133	18	1.622	0.464	134	1	3.224	0.959	182	1
66	24.1	.....	47	1	0.813	0.233	.....	.....	.....	.....	.....	.....
67	.....	.....	169	9	2.107	0.603	.....	.....	.....	.....	.....	.....

TABLE I.—*Showing the individual tree yield of Para rubber in Abucay, Bataan*—Continued

Tree No.	Girth 3 feet from the base		April 12, 1926–May 15, 1927				June 15, 1927–July 17, 1928				October 15, 1928–November 15, 1929	
			Tapping days				Tapping days				Tapping days	
	April 1926	July 1929	Yielding	Non yielding	Latex	Dry rubber	Yielding	Non yielding	Latex	Dry rubber	Yielding	Non yielding
	Inches	*Inches*			*Liters*	*Kilos*			*Liters*	*Kilos*		
68	18.7	.....	29	.....	0.741	0.212	.....	.....	.....	.....	.....	.....
69	22.0	27.2	122	53	0.851	0.243	128	7	2.543	0.756	156	27
70	35.2	.....	58	1	1.713	0.490	.....	.....	.....	.....	.....	.....
71	24.6	.....	59	.....	0.934	0.267	.....	.....	.....	.....	.....	.....
72	35.2	.....	57	2	1.334	0.381	.....	.....	.....	.....	.....	.....
73	32.3	33.9	143	34	2.608	0.746	123	12	4.142	1.232	183	.....
74	13.2	21.6	150	27	1.111	0.318	115	.....	2.700	0.803	181	2
75	33.3	43.7	176	1	3.042	0.870	135	.....	5.560	1.653	182	1
76	13.5	.....	24	1	0.041	0.012	.....	.....	.....	.....	.....	.....
77	22.7	37.0	175	2	3.376	0.966	135	.....	4.241	1.261	181	2
78	30.5	42.9	156	21	3.857	1.103	133	2	7.048	2.095	183	.....
79	31.3	45.1	172	5	5.790	1.656	134	1	8.456	2.514	177	6
80	14.2	21.6	164	13	1.385	0.396	128	7	2.351	0.699	180	3
81	25.8	27.9	174	2	8.747	2.501	135	.....	8.913	2.650	178	5
82	27.4	38.6	162	14	4.792	1.370	130	5	4.546	1.352	177	6
83	16.2	24.8	162	14	1.987	0.568	135	.....	3.351	0.996	181	2
84	24.6	33.1	172	4	3.241	0.927	124	11	2.662	0.792	160	23
85	31.2	39.4	158	2	6.142	1.756	132	3	6.286	1.869	179	4
86	24.2	38.9	149	4	5.949	1.701	135	.....	8.017	2.384	182	1
87	26.4	36.2	120	7	1.106	0.316	128	7	2.638	0.784	168	15
88	24.5	30.7	126	1	2.517	0.720	133	2	6.267	1.863	182	1
Total	2,284.7	2,895.2	14,202	504	491.247	140.206	10,330	149	459.926	136.642	13,739	306
Average	26.26	37.6	162.5	.....	5.581	1.589	132.4	.....	5.896	1.752	178.4	.....

Tree No.	October 15, 1928 to November 15, 1929 — Tapping days		Total			Average yield per tapping day		Remarks
	Latex	Dry rubber	Tapping days	Latex	Dry rubber	Latex	Rubber	
	Liters	*Kilos*		*Liters*	*Kilos*	*cc.*	*Grams*	
1	7.541	2.317	489	18.557	5.529	37.94	11.30	Partly hacked.
2	5.765	1.772	496	18.986	5.588	38.27	13.28	Roots exposed, trunk partly burned.
3	17.929	5.510	496	42.394	12.628	85.47	25.46	Trunk partly burned.
4	.....	.....	178	3.538	1.012	19.87	5.68	Healthy.
5	5.091	1.564	496	10.561	3.165	21.28	6.38	Do.
6	10.022	3.080	496	22.363	6.677	45.08	13.46	Do.
7	8.244	2.533	496	16.048	4.814	32.35	9.70	Roots exposed, trunk partly burned.
8	7.297	2.242	496	19.296	5.713	38.90	11.51	Trunk partly burned.
9	7.155	2.199	496	15.617	4.672	31.68	9.42	Healthy.
10	9.803	3.012	496	26.265	7.809	52.95	15.74	Trunk partly burned.
11	3.307	1.016	496	6.644	1.991	13.39	4.01	Healthy.
12	7.506	2.307	496	26.109	7.729	52.63	15.58	Do.
13	18.163	5.581	496	32.145	9.678	64.80	19.51	Do.
14	5.122	1.574	496	11.927	3.566	24.04	7.19	Do.
15	7.583	2.330	496	16.584	4.962	33.43	10.00	Do.
16	27.835	8.554	496	62.692	18.697	126.39	37.69	Healthy with exposed roots.
17	10.701	3.288	496	26.011	7.740	52.44	15.60	Do.
18	10.221	3.141	496	26.068	7.474	52.55	15.06	Do.
19	15.733	4.835	497	43.331	12.866	87.18	25.88	Do.
20	6.485	1.993	497	23.632	6.980	47.55	14.04	Do.
21	.....	.....	179	4.590	1.313	25.64	7.33	Hacked trunk and roots exposed. Broken.
22	5.489	1.687	497	12.816	3.826	25.78	7 69	Healthy with exposed roots.
23	7.675	2.359	497	18.861	5 611	37.95	11.29	Trunk partly burned and exposed roots. Destroyed one-half of its bark.
24	10.541	3.231	497	34.294	10.140	69.00	20.40	Healthy with exposed roots.
25	3.873	1.190	497	9.510	2.736	19.13	5.50	Do.
26	6.027	1.852	497	12.691	3.801	25.53	7.64	Do.
27	8.238	2.532	497	20.980	6.245	40.20	12.56	Trunk partly burned and with exposed roots.
28	6.807	2.092	497	19.743	5.851	39.92	11.77	Trunk partly burned.
29	4.373	1.344	497	9.285	2.781	18.68	5.59	Healthy.
30	.....	.....	179	11.420	3.266	63.80	18.25	Healthy and part of roots exposed. Broken.
31	6.528	2.006	497	24.011	7.079	48.31	14.24	Do.
32	11.313	3.476	497	40.323	11.908	81.13	23.96	Do.

TABLE I.—*Showing the individual tree yield of Para rubber in Abucay, Bataan*—Continued

Tree No.	October 15, 1928 to November 15, 1929		Total			Average yield per tapping day		Remarks
	Tapping days							
	Latex	Dry rubber	Tapping days	Latex	Dry rubber	Latex	Dry rubber	
	Liters	*Kilos*		*Liters*	*Kilos*	*cc.*	*Grams*	
33	2.902	0.892	465	9.900	2.916	21.29	6.27	Trunk partly burned and with exposed roots. Rested.
34	2.881	0.885	497	6.910	2.062	13.90	4.15	Trunk partly burned. Destroyed one-half of its bark.
35	5.592	1.718	497	21.151	6.239	42.55	12.55	Healthy.
36	8.456	2.599	497	20.862	6.209	41.97	12.49	Trunk partly burned and roots partly exposed.
37	7.037	2.162	498	18.156	5,408	36.45	10.86	Trunk attacked by white ants.
38	7.473	2.296	498	28.871	8.543	57.97	17.15	Healthy.
39	5.261	1.617	498	14.103	4.196	28.32	8.42	Do.
40	5.773	1.774	498	12.417	3.713	24.93	7.45	Healthy, destroyed one-half of its bark.
41	6.401	1.967	598	12.665	3.796	25.43	7.62	Healthy and part of roots exposed.
42	22.660	6.963	498	48.006	14.338	96.40	28.79	Do.
43	2.787	0.856	496	6.419	1.915	12.94	3.86	Healthy, destroyed one-half of its bark.
44	16.426	5.048	498	45.849	13.622	92.06	27.35	Do.
45	2.326	0.715	498	8.205	2.435	16.47	4.89	Trunk attacked by white ants.
46	8.249	2.535	432	22.233	6.603	51.46	15.28	Healthy and part of roots exposed.
47	25.881	7.953	498	52.687	15.774	105.79	31.67	Healthy, destroyed one-half of its bark.
48	6.291	1.933	498	16.599	4.948	33.33	9.73	Do.
49	5.584	1.716	497	14.082	4.198	28.33	8.44	Healthy and troots partly exposed.
50	8.133	2.499	497	19.242	5.738	38.71	11.54	Do.
51	5.998	1.843	497	12.887	3.856	25.93	7.75	Healthy.
52	12.756	3.920	497	27.505	8.228	55.34	16.55	Healthy and roots partly exposed. Destroyed one-third of its bark.
53	15.995	4.915	497	36.574	10.941	73.59	22.01	Healthy.
54	4.784	1.470	497	14.085	4.188	28.34	8.42	Healthy and roots partly exposed.
55	7.089	2.178	497	18.456	5.497	37.13	11.06	Do.
56	4.846	1.489	497	9.723	2.914	19.56	5.86	Do.
57	.....	.....	307	6.341	1.852	20.65	6.03	Healthy. Destroyed one-half of its bark.
58	4.638	1.425	497	9.970	2.994	20.06	6.02	Do.
59	17.869	5.491	497	42.239	12.588	84.98	25.32	Do.
60	11.203	3.443	497	23.167	6.948	46.61	13.98	Do

61	4.765	1.464	497	10.820	3.230	21.77	6.49	Healthy. Destroyed one-half of its bark.
62	9.986	3.069	497	22.555	6.746	45.38	13.57	Healthy. Destroyed one-half of its bark.
63	3.743	1.150	497	8.971	2.678	18.05	5.38	Do.
64	7.138	2.194	497	16.770	5.003	33.74	10.06	Hacked trunk. Destroyed one-half of its bark.
65	5.817	1.788	469	10.663	3.211	22.73	6.84	Healthy.
66			48	0.813	0.233	14.85	4.85	Trunk partly burned. Rested June 15–26 and finally died in August.
67			178	2.107	0.603	11.83	3.38	Trunk partly burned and roots partly exposed. Dead.
68			29	0.741	0.212	25.55	7.31	Trunk partly burned. Died in August.
69	2.792	0.858	493	6.186	1.857	12.54	3.56	Trunk partly burned.
70			59	1.713	0.490	29.03	8.30	Trunk partly burned. Died in August.
71			59	0.934	0.267	15.83	4.52	Do.
72			59	1.334	0.381	22.61	6.45	Trunk partly burned and roots partly exposed. Died in August.
73	4.594	1.412	495	11.344	3.390	22.91	6.84	Healthy.
74	5.874	1.805	475	9.685	2.926	20.39	6.16	Healthy. Rested.
75	9.841	3.024	495	18.443	5.547	37.05	11.20	Do.
76			25	0.041	0.012	1.64	0.48	Healthy. Burned April 22 and died in June, 1926.
77	6.603	2.029	495	14.220	4.256	28.72	8.59	Healthy.
78	13.103	4.027	495	24.008	7.225	48.50	14.59	Do.
79	13.462	4.137	495	27.708	8.307	55.97	16.78	Do.
80	4.632	1.423	495	8.368	2.518	16.90	5.08	Do.
81	6.456	1.984	494	24.116	7.135	48.79	14.44	Do.
82	7.243	2.226	494	16.581	4.948	33.56	10.01	Trunk attacked by white ants.
83	4.758	1.462	494	10.096	3.026	20.43	6.12	Do.
84	5.898	1.812	494	11.801	3.531	23.88	7.14	Healthy.
85	6.961	2.139	478	19.389	5.764	40.56	12.06	Do.
86	12.236	3.760	471	26.202	7.845	55.63	16.65	Do.
87	2.141	0.658	445	5.885	1.758	13.22	3.95	Do.
88	6.725	2.067	445	15.509	4.650	34.85	10.45	Hacked trunk with one-third of its bark destroyed.
Total	642.426	197.407	39,230	1,593.599	474.255	3,410.66	1,015.47	
Average	8.343	2.564	445.8	18.109	5.389	38.76	11.54	

NOTE.—No tapping from October 15, 1927, to November 15, 1927, and from August 15, 1928, to September 15, 1928.

CRITERIA OF PLANT GROWTH AND THEIR RELIABILITY [1]

By H. S. Reed
Of the University of California

The results of experiments in plant nutrition are often estimated only in terms of the growth of plant substance. Growth is a complex thing, far from being clearly understood, but we understand that it is important for the plant to grow and have found that treatments which promote growth are likely to be valuable when applied to agricultural operations. Growth is a process. The plant is the product. We commonly assume that if the process runs smoothly a plant will reach its maximum development in due course of time. The rub comes when one has to decide which set of plants has made the best growth. There are various features which appeal to experimenters in the field of plant physiology as criteria of growth; some use one feature and others use another. Is it possible to reduce somewhat the confusion which has arisen from the lack of a uniform criterion of growth?

For many years the results of field experiments on the effect of fertilizers were judged by the number of bushels of threshed grain harvested from different plots. As a supplement, some experimenters made photographs of the standing grain in the field, including some Beau Brummel who served as an anthropoid yardstick. Since the results of the field experiment, however, are admittedly difficult to interpret, the use of cultures in pots or in solutions was later considered a more refined method of experimenting. The accounts of these experiments were often enveloped in a host of esoteric terms (hydrogen-ion concentration, solution pressure, dissociation, ionic velocity, etc.) which were expected to inspire respect for the technic, if not for the results. Unfortunately the results have not been measured with the same degree of refinement as that shown in the technic of installing the cultures. The water may be redistilled, the salts recrystallized, the glassware wash-

[1] Read at the annual meeting of the Western Society of Soil Science held at Pasadena, California. (June 15–16, 1931.)

ed, not seven times, but seventy times seven, and the temperature controlled by delicate regulators, but the plant growth is measured with so little accuracy that nothing except enormous differences has any significance. Would greater accuracy of measurement make little differences more significant?

DRY WEIGHT

Dry weight as a measure of the growth of the plant was used by most of the earlier workers in the field of plant nutrition.

A moment's reflection, however, ought to show that dry weight in itself is not particularly adapted to serve as a criterion of the effects of substances used as fertilizers or soil amendments.

Let us notice what constitutes the weight of an oven-dried plant: first, the scaffolding of the plant, composed of cellulose and woody material; second, the mineral compounds derived from the soil and known as "ash constituents" because no one has the temerity to call them "cinders"; and third, a variety of synthetic products of cellular activity which are present in smaller amounts in most plants.

The cellulose scaffold is largely composed of substances derived from carbon dioxide and water. As such, it may be considered as a product of the carbohydrate metabolism of the plant and in turn of the photosynthetic efficiency of the leaf. The combustible substances constitute 75 to 95 per cent of the dry weight of a plant and the major portion of that is cellulose in modified conditions. The dry weight of plants, therefore, is chiefly the weight of carbohydrate and its derivatives and should be recognized as such.

It is well known that there may be growth without any increase in dry weight or even with a loss of dry weight. A small stunted plant may have a greater dry weight than a thrifty plant because an impaired metabolism prevents the use of synthetic products.

The plant has the ability to move certain ions, such as potassium, to the site of special functions utilizing them repeatedly. However, other ions, such as iron, are relatively immobile in the plant.

In the days of our youth we were duly intimidated with the importance of osmosis and imbibition, which were advertised as a pair of sprightly water carriers. They were considered the *sine qua non* of absorption since we supposed that when the water was sucked into the plant the dissolved substances were pulled along. We know, however, that dissolved substances may

move either with or against the imbibitory current and that their abundance in the plant may or may not have significance. Our ideas of the utility of the ash constituents and their salts have also experienced a modification. Once we thought of them as the raw material which constituted an important part of the plant structure and we considered a fertile soil to be one which could furnish the proper ions in suitable proportions. But now we know that soil fertility is something far more than the content of ions, and that some very essential ions are present in such small amounts that very special methods of analysis must be used to find them. Such elements must influence growth as catalysts. Perhaps all the mineral elements regarded as essential have some sort of catalytic action.

The ash constituents form only a small proportion of the dry weight of a plant and are probably the residues of material which has served its purpose but cannot be excreted except by the abscission of foliar organs and fruits.

Lastly the more complex synthetic products of vital activity represent a small part of the dry weight, but are highly important to the well-being of the plant. They are not usually present in large amounts because the processes of growth use them continually as sources of energy, although certain compounds, such as amino acids, have a dominant influence upon growth.

TRANSPIRATION

The value of the transpired water from plants as a criterion of their growth is greater than is usually recognized. It is a reliable measure of the development not only of the aërial portions of the plant but of the root system. It is an especially good criterion for the growth of cereal plants which are so frequently used for experiments in plant nutrition. The aërial parts of a graminaceous plant consist mainly of leaves during a large part of the grand period of growth. The leaves are linear and grow as a result of the activity of a group of basal meristematic cells enveloped somewhat by the bases of older leaves.

The reliability of transpiration as a criterion of growth of young cereal plants was extensively investigated 25 years ago by physiologists connected with the U. S. Bureau of Soils. Many objections to the method were raised on *a priori* grounds; few, if any, were supported by experimental data.

The transpiration represented very accurately the growth of wheat plants in soils or in solution cultures and responded to

any treatment which increased the growth of plants, especially root growth. The transpiration of good plants grown in fertile soil was greater than that of poor plants in infertile soil. The ration of transpiration to weight was very constant. Naturally, one does not obtain absolute figures by this method; the results are always expressed as a ratio of the transpiration of the control plants over the same period of time and grown in the same environment. One may determine the relative transpiration without injury to the plants for any desired time interval.

Livingston [2] published experimental data which compare the relative increases in transpiration, green weight, and dry weight of wheat plants grown in a soil extract to which four additions of sodium nitrate were made. The amounts added were 50 p. p. m., 100 p. p. m., 200 p. p. m., and 400 p. p. m. Sodium nitrate shows its growth-promoting effect chiefly in increasing the growth of the tops of wheat seedlings, and only slightly in the growth of their roots. The relative increases in the three sets of measurements show that, according to the transpiration, there was a pronounced increase in growth resulting from each addition. The three lower amounts produced approximately equal effects, but the addition of 400 p. p. m. sodium nitrate produced the greatest effect.

Judged by the relative green weight there was a pronounced increase from the addition of 50 p. p. m. and a larger but similar increase from the addition of the three higher amounts of nitrate of soda.

Judged by the relative dry weights of the plants, the addition of 50 p. p. m. resulted in an insignificant increase; 100 p. p. m., the largest increase; and 200 and 400 p. p. m., intermediate increases. The results revealed by the transpiration and by green weight are essentially in harmony but those revealed by the dry weights of the plants are somewhat dissonant.

FRESH WEIGHT

Of all the criteria of growth, fresh weight has been less utilized than almost any other. Those who strive for quasi-accuracy scorn fresh weight because the plants cannot be weighed on a delicate balance and a figure replete with decimals obtained. Well, why should it? Is a plant a precipitate? Is it

[2] LIVINGSTON, B. E. Further studies on the properties of unproductive soils. U. S. Dept. Agr. Bur. Soils, Washington, Bul. 36. 1907.

not changing continually if it is growing, and are we not trying to measure the integration of the many changes which constitute growth?

In view of the dependence of growth upon the hydration of colloidal substances in the plant it seems entirely fitting that we should include the water with the plant.

Growth in size is due almost entirely to cell elongation which is dependent upon turgor which stretches the cell walls. I venture to remind you that MacDougal,[3] Bartholomew,[4] and others have shown that the daily increments in size of plants or of plant organs were definitely correlated with increases in water supply or with decreases in water losses. You will recall that MacDougal and Spoehr[5] found that amino acids in extremely dilute solutions exerted a great influence in the swelling of pentosan-protein colloids. I need hardly remind you that the rapid growth of seedlings and the spring growth of perennial plants occur immediately after there has been a splitting of proteins into their amino-acid constituents, concomitant with the presence of a supply of water adequate for the processes of absorption. I see no valid objection to the concept that these increases in volume are growth. A distention of the cell produces tensions in the walls which result in permanent increments of surface. The summation of the enlargement of many cells is the enlargement of the organism.

I want to emphasize the idea that the water got into the plant because of something which the plant produced. Its presence is, therefore, an index of metabolic processes which are characteristic of living things, especially indicative of those processes by which organisms grow in volume. I venture to urge the propriety, if not the necessity of including the water with the other components of the plant.

The conclusion from the evidence thus far presented seems to speak strongly in favor of the use of fresh weight of plant material as a criterion of growth. If only one measure of growth is use, this is unquestionably the one to use.

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[3] MacDougal, D. T. Growth in trees and massive organs of plants. Carnegie Inst. of Washington, Pub. 350. 1924.

[4] Bartholomew, E. T. Water deficit in lemon fruits caused by excessive leaf evaporation. Amer. Jour. Bot., 13: 102–117. 1926.

[5] MacDougal, D. T., and Spoehr, H. A. Hydration effects of amino-compounds. Proc. Soc. Experimental Biology and Medicine, 17:33–36. 1919.

SIZE INCREMENTS

In many types of experiments the growth of the plant must be determined at intervals during the grand period of growth. Since it is imposible, therefore, to cut and weigh the plant more than once, the investigator is compelled in such cases to measure its length or circumference and to handle it with as little risk of injury as possible. A degree of error is involved in this method, depending on the experience of the operator. The energy of the plant which is expended in the production of leaves, flowers, and fruits is not likely to be measured accurately by this method. The most that one can do is to select enough individuals to increase the statistical reliability of the average result.

Bruner and Weaver [6] compared the height, fresh weight, dry weight, and average leaf area of three cereals grown at three stations in Nebraska with significant differences in climatic conditions. Their results indicate that the fresh weight of plant and area of leaves show similarity in the order of differences. The order of differences indicated by the average height and total dry weight of plant also shows a certain parallelism. The correspondence between fresh weight and dry weight is very poor.

The results of their measurements give little basis for confidence in the value of height measurements as an index of growth in the cereals.

VARIABILITY IN GROWTH

To call your attention to the inherent variability in organisms is perhaps unnecessary.

We all recognize that the results of a single experiment are often, if not usually untrustworthy; yet investigators have often published the results of single experiments and drawn conclusions from them. For those unfortunates who are working for doctors' degrees this may be expedient, but not justifiable. No matter how well planned they may be, culture experiments cannot be expected to give results which will invariably be obtained when the experiments are repeated.

I think it is high time that we placed our reliance upon something having a greater statistical significance than the results

[6] BRUNER, W. E., and WEAVER, J. E. Size and structure of leaves of cereals in relation to climate. Univ. of Nebr. Studies XXIII, Nos. 3–4. 1924.

obtained with ten plants in a culture jar. Davis [7] showed that the same results may be obtained with culture solutions differing greatly in their mean plant-producing power, and that reliability could only be attained by the use of a sufficiently large population to approximate the true mean.

If it is impossible to obtain perfect accuracy, it is not impossible to fix the limits of error and thus to determine whether the differences obtained are due to differences in the factors studied or to unavoidable errors—that is, whether the differences are significant. Any series of determinations based on apparently homogeneous material will be grouped around a mean value from which the individual determinations will depart more or less widely. If the values are widely scattered we know that the accuracy of the mean is low and that a large probable error must be expected. Before drawing any conclusions from experiments of this kind it is necessary to know whether the differences observed are any greater than those which might have been obtained if all the cultures had received the same treatment. Unless there be odds of 30 to 1 that the differences are real and not due to chance, there cannot be any great reliance placed upon the results.

The careful investigator will realize that the criteria employed will depend somewhat upon the nature of the experiment and that perhaps more than one set of measurements must be taken. He is not studying a reaction between two pure substances in a beaker, but a complex process involving some obscure factors.

I have tried to emphasize the necessity of better methods for measuring the growth of plants in experimental cultures. I feel that improvement in the methods of recording results is strictly in order with refined methods of experimentation, especially when plant growth is used as the criterion of some physical or chemical factor of the environment. If we are going to measure plants we ought to take measurements which will most correctly represent the integrated response of the plant to the conditions under which it grew, in other words, the product of that process of autocatakinesis which we call growth.

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[7] DAVIS, A. R. The variability of plants grown in water cultures. Soil Sci., 11:1–32. 1921.